AD-A093 295 ARINC RESEARCH CORP ANNAPOLIS MD F/G 13/10
IN SUPPORT OF THE DEVELOPMENT PHASE OF THE AMPHIBIOUS ENGINEERE--ETC(U)
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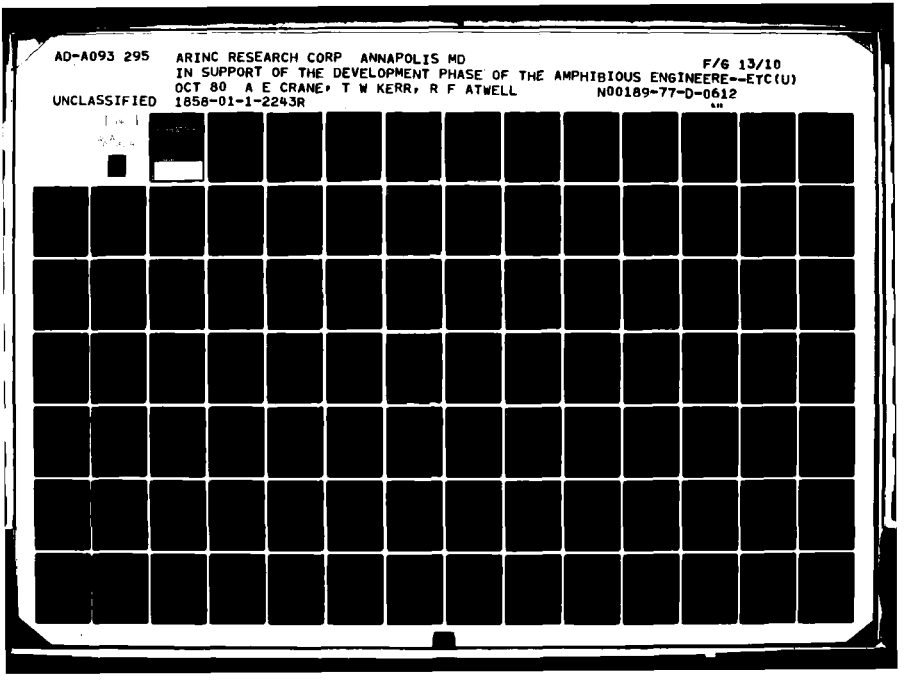

Publication 1858-01-1-2243R

INTERIM REPORT

IN SUPPORT OF THE DEVELOPMENT PHASE OF THE AMPHIBIOUS ENGINEERED OPERATING CYCLE (PEOC) PROGRAM FOR THE USS TARAWA (LHA-1) CLASS

July 1980
(Revised October 1980)

Prepared for
OFFICER IN CHARGE
PLANNING AND ENGINEERING FOR
REPAIRS AND ALTERATIONS [PERA (ASC)]
PORTSMOUTH, VIRGINIA 23709
under Contract N00189-77-D-0612

ARINC RESEARCH CORPORATION

[redacted]

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: 1858-01-1-2243R / 2. GOVT ACCESSION NO.: AD-A093295	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): In Support of the Development Phase of the Amphibious Engineered Operation Cycle (PEOC) Program for the USS Tarawa (LHA-1) Class. Revision. (14)	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER: 1858-01-1-2243R
7. AUTHOR(s): (10) A. E. Crane, T. W. Kerr, R. F. Atwell	8. CONTRACT OR GRANT NUMBER(s): (15) N00189-77-D-0612
9. PERFORMING ORGANIZATION NAME AND ADDRESS: ARINC Research Corp. 2551 Riva Road Annapolis, Md. 21401	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (11) Oct 80
11. CONTROLLING OFFICE NAME AND ADDRESS: Officer In Charge, Planning & Engineering for Repairs & Alterations (PERA (ASC)) Portsmouth, VA 23709	12. REPORT DATE: July 1980
	13. NUMBER OF PAGES: 93
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (9) Interim rept, (12) 93	15. SECURITY CLASS. (of this report)
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report): Unlimited	This [illegible] for [illegible] distribution [illegible]
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	
18. SUPPLEMENTARY NOTES	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number): Engineered Operating Cycle; USS Tarawa; Amphibious Class Ships	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number): This report presents the results of a study conducted in support of the Amphibious Engineered Operating Cycle (PEOC) Program for the USS TARAWA (LHA-1) Class ships. It describes tasks performed to collect data and identify maintenance-critical systems and equipments. It also addresses alternations and pre-EOC overhaul requirements.	

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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by

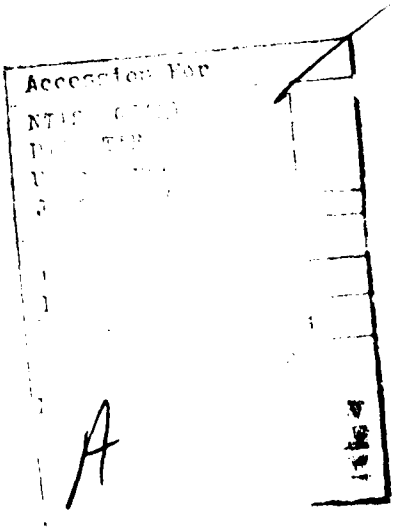
A.E. Crane
T.W. Kerr
R.F. Atwell

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

Publication 1858-01-1-2243R

ABSTRACT

This report presents the results of a study conducted in support of the Amphibious Engineered Operating Cycle (PEOC) Program for the USS TARAWA (LHA-1) Class ships. It describes tasks performed to collect data and identify maintenance-critical systems and equipments. It also addresses alterations and pre-EOC overhaul requirements.



SUMMARY

This report presents the results of an initial engineering analysis conducted as part of the development phase of an Amphibious Engineered Operating Cycle (PEOC) Program for the USS TARAWA (LHA-1) Class ships. The study addresses the following topics:

- Development phase requirements, including a plan of action and milestones;
- Ship class engineering and maintenance data;
- Maintenance-critical systems and equipments;
- Alteration requirements;
- Systems engineering analysis requirements; and
- Pre-EOC overhaul requirements.

A plan of action and milestones (POA&M) was originally developed in 1978 during the initiation phase of the LHA-1 Class EOC Program. The POA&M and EOC Program development phase requirements were updated to reflect current objectives and constraints. These revised requirements and POA&M, which were delivered to Planning and Engineering for Repairs and Alterations [PERA (ASC)] in Portsmouth, Virginia, in October 1979, have subsequently been revised. They will require periodic revision as program development continues.

The development phase of the EOC Program began with the collection of detailed engineering and maintenance data for the ship class. Collected data and data to be obtained are summarized and discussed in this report. Analysis of the collected data indicated that design data, supplemented by available historical data, may be used for projecting EOC Program maintenance requirements.

Maintenance-critical systems and equipments of the LHA-1 Class were categorized in this study as those systems or equipments with an accumulated critical maintenance action burden of 100 or more total man-hours. Critical maintenance actions were identified as corrective maintenance actions performed on an identified system or equipment that had been reported as inoperative or in a reduced state of capability. There were 119 ship work authorization boundary (SWAB) groupings that fulfilled this criterion. In terms of reported maintenance problems, these 119 maintenance-critical

systems and equipments are the most significant; as such, they have the greatest probability of providing a return on future investments of engineering analysis resources.

Current class alterations were reviewed to assess their potential impact on maintenance-critical systems and equipments and to determine if current priorities and schedules for accomplishment were adequate in relation to EOC Program objectives. In general, current priorities and scheduling were found to be adequate.

Future requirements for engineering analysis were refined by considering (1) if a maintenance-critical system or equipment represented a maintenance burden large enough to be categorized as a problem, (2) if the problem was currently subject to correction through an alteration or other pending technical action, and (3) if the system or equipment installed in another ship class had previously been subjected to an engineering analysis as part of another EOC Program. Of the 119 SWAB groupings identified as containing systems or equipments exhibiting a historical critical maintenance burden in excess of 100 man-hours, no single equipment or system appeared to have compiled a maintenance burden sufficient to merit further detailed engineering analysis. However, when maintenance-critical items were considered aggregately in relation to the shipbuilder's maintenance burden predictions, nine LHA-1 Class plans for maintenance (PFMs) were identified as appearing to have inadequately defined maintenance requirements. These PFMs were further combined into six functional groupings to facilitate analysis; the groupings are as follows:

- Damage control monitoring and interior communications systems
- Saltwater and ballast systems
- Hull and hull fittings, including preservation and painting
- Aircraft handling and assault systems
- Ventilation systems
- Radio communications systems

A judgment of PFM inadequacy was made on the basis of the results of analysis, which indicated that certain selected equipments from each PFM had accumulated a corrective maintenance man-hour burden greater than that projected by the PFM for all included equipments. Because these PFMs appear to have inadequately defined maintenance burden predictions, it is probable that other elements of the integrated logistics support (ILS) package (such as parts support) are also deficient. Suitability of these systems as candidates for a systems engineering analysis (SEA) was corroborated by PERA (ASC) through consideration of factors independent of the process and data by which these systems were selected. Corroboration consisted of a comparative analysis of maintenance burden criticality for functionally similar systems as reflected within the following:

- DDEOC maintenance-critical systems/equipment lists for the DDG-2, DDG-37, and FF-1052 ship classes

- DDEOC system maintenance analysis (SMA) documents
- PEOC maintenance-critical systems/equipments lists from the PEOC Initiation Study for the LST-1179 and LPD-4 ship classes
- LHA-1 Class PSA/RAV work package summaries

Possible pre-EOC overhaul requirements were examined to determine if the maintenance history of the class would support a recommendation for pre-EOC overhaul. On the basis of a detailed review of data accumulated for maintenance-critical items with the most significant maintenance burden, it was concluded that reported failure modes were not indicative of a deteriorated state of material condition. It is recommended that ships of the LHA-1 Class be entered into the EOC Program subsequent to completion of regular overhaul (ROH).

The next effort recommended for accomplishment in the LHA-1 Class EOC development phase is the performance of SEAs and the development of a class maintenance plan (CMP). Because analysis of the collected historical data indicates that these data alone are insufficient for the definitive development of CMP projections, the SEA and CMP development process must use design data supplemented by historical data compiled by other ship classes. Information presented in this report indicates that there are sufficient data to establish the feasibility of such an approach.

The CMP should be developed in conjunction with the accomplishment of SEAs. The CMP is a synthesis of information from various sources, including the SEAs; the latter provide only a partial compilation of EOC Program maintenance requirements. Other sources of information, such as the shipbuilder's design data, other EOC CMPs, and historical data for common equipments from other ship classes, must be researched to document the intermediate maintenance activity (IMA) and depot level maintenance strategy for systems and equipments not subject to an SEA.

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

In June 1978 the Naval Sea Systems Command (NAVSEA) completed an initiation study* concerning the feasibility of applying an engineered operating cycle (EOC) concept to amphibious ships. The results of this study were forwarded to the Chief of Naval Operations, and in October 1979 approval was granted for development of the Amphibious Engineered Operating Cycle (PEOC) Program. The LHA-1 Class, consisting of five ships commissioned since May 1976, was designated as the first priority with development phase efforts to be time-dispersed to accommodate budget constraints. Other amphibious ship classes to be included in the PEOC Program are the LPH-2, LPD-4, LSD-36, LST-1179, and LKA-113.

For each ship class, the PEOC Program consists of three distinct phases. These phases, as delineated in the NAVSEA *Engineered Operating Cycle Program Development Manual*,** are an initiation phase, a development phase, and an implementation phase. The objective of the initiation phase is to assess the current status of ship class material condition and evaluate the feasibility of the proposed program. The development phase consists of the detailed engineering effort necessary to support definition of the proposed EOC maintenance strategy. The implementation phase executes the maintenance plan. Figure 1-1 is the time schedule for each EOC Program phase for each of the PEOC ship classes. As indicated, the three phases of each ship class EOC Program have been time-dispersed. The initiation phase for the LHA-1 Class was completed concurrently with the PEOC Program initiation study. Accordingly, this report describes efforts associated with the commencement of the LHA-1 Class EOC Program development phase. The total LHA-1 Class development phase will require three years; it will be documented through the publication of additional reports as development phase efforts continue.

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*Amphibious Engineered Operating Cycle (PEOC) Program Initiation Study Report, Volumes I and II, June 1978, ARINC Research Publication 1853-01-1-1761 prepared under Contract N00189-77-D-0612.

**Engineered Operating Cycle Program Development Manual, August 1978, ARINC Research Publication 1822-01-1-1797 prepared under Contract N00140-77-D-0417.

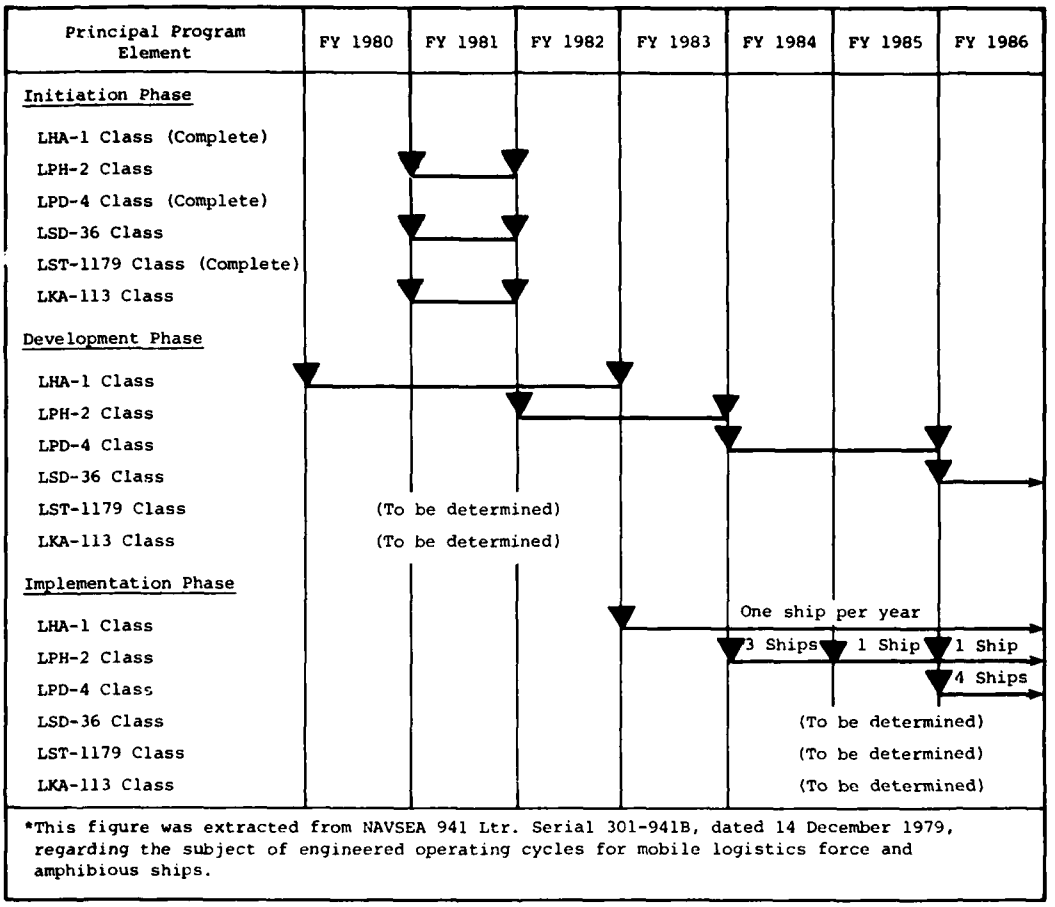

Figure 1-1. PRINCIPAL PROGRAM ELEMENTS AND SCHEDULE FOR THE AMPHIBIOUS ENGINEERED OPERATING CYCLE (PEOC) PROGRAM

The principal effort throughout the development phase will be the conduct of engineering analyses of critical ship systems and equipments to develop an accurate class maintenance plan. Additional efforts will include the development of a program management plan and procedures for assessing and monitoring ship material condition and the effectiveness of the EOC Program. During the EOC development phase, pertinent detailed technical, operational, and experience data will be assembled; from these data, maintenance-critical equipments and systems will be selected, beneficial technical and fleet modernization program (FMP) alterations will be identified, and maintenance requirements will be developed.

This report describes efforts to collect data and select maintenance-critical systems and equipments as candidates for in-depth systems engineering analyses. Alterations and pre-EOC overhaul requirements are also examined.

Chapter Two of this report describes the approach, Chapter Three (supplemented by the appendixes) describes the results of the study, and Chapter Four presents conclusions and recommendations derived at this point in the LHA-1 Class EOC development phase.

CHAPTER TWO

APPROACH

The approach used for the LHA-1 Class EOC development phase efforts was adapted from the Naval Sea Systems Command *Engineered Operating Cycle Program Development Manual*. This document, together with the *Amphibious Engineered Operating Cycle (PEOC) Program Initiation Study Report*, served as a guide in identifying selected EOC development phase tasks that could be accomplished early and within available resources. These early efforts will serve as a departure point for continuing EOC development when further resources become available. The following tasks were selected for the EOC development phase:

- Document development phase requirements, including an updated plan of action and milestones (POA&M) for their accomplishment
- Collect detailed engineering maintenance data for the LHA-1 ship class
- Identify maintenance-critical systems and equipments
- Refine requirements for systems engineering analyses
- Identify alteration requirements
- Develop pre-EOC overhaul requirements

2.1 DOCUMENT DEVELOPMENT PHASE REQUIREMENTS AND UPDATE POA&M

Development phase requirements for the LHA-1 Class EOC Program and a POA&M for accomplishment were extracted from the PEOC initiation study report, updated to reflect current objectives and constraints, and delivered to PERA (ASC) in October 1979. The POA&M was subsequently revised in January 1980, and it will continue to be revised as the program progresses. Because the POA&M is dynamic by nature, and because the baseline for its development is currently documented in the NAVSEA EOC Program development manual, a detailed discussion of the various development phase requirements is not repeated in this report.

2.2 COLLECT DETAILED ENGINEERING AND MAINTENANCE DATA FOR THE LHA-1 SHIP CLASS

Data collection for the EOC Program development phase included identification, selection, and collection of data elements required to support the entire EOC development phase effort. Data previously collected during the LHA-1 Class EOC initiation phase were inventoried to determine data element deficiencies, and additional data items not previously available were obtained or identified as required data.

All major categories of data were addressed and compiled to the extent that an appropriate source could be identified, availability could be determined, and need could be established. Major categories of data in this data collection effort included the following:

- Ship class configuration data
- Current maintenance strategy data
- Ship system technical data
- Historical maintenance data
- Ship modernization data
- Shipbuilder's design data
- Other, miscellaneous data

Appendix A describes various data sources used in this study, together with other data elements obtained or identified for procurement for use during future LHA-1 Class EOC development phase efforts.

2.3 IDENTIFY MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS

Maintenance-critical systems and equipments were identified through an analysis of documented historical maintenance data compiled by forces afloat via the Navy maintenance data system (MDS) and consolidated casualty reporting (CASREP) system. The MDS data consisted of all maintenance transactions reported by LHA-1 and LHA-2 from each ship's commissioning through October 1979. MDS data for other ships of the class were not available. The CASREP data covered the same operational data period (3.4 years for the LHA-1, and 2.0 years for the LHA-2). Data analysis was conducted at the equipment level, with allowance parts list (APL) numbers being used where such numbers were reported; and at the system level, with equipment identification code (EIC) numbers being used where an APL number was not reported. APL numbers were chosen as the principal level of identification because (1) they are more consistent than EIC numbers for identification of specific equipments, (2) MDS and CASREP documented APL numbers may be validated through comparisons with baseline configuration data, and (3) CMP tasks to be derived through subsequent detailed analyses of critical maintenance items and other sources will be defined at individual APL levels.

Because APL and EIC numbers, as documented by fleet maintenance personnel, are often inconsistent or inaccurate, definitive analysis of the MDS and CASREP data is not possible without some means of screening and validating identification numbers recorded in the data base. Accordingly, to analyze the MDS and CASREP data, it was necessary (1) to identify an appropriate baseline of configuration data, (2) to establish appropriate criticality criteria, and (3) to analyze and summarize the available documented maintenance history through application of the criticality criteria.

2.3.1 Identify Configuration Data

Configuration data for the USS TARAWA (LHA-1) and USS SAIPAN (LHA-2) were obtained from a computer tape provided by the Navy Ships Parts Control Center (SPCC). Information on APL applicability to other ships of the LHA-1 Class was not available.

Because of the anticipated need to compare multiple data bases using various levels of equipment identification, it was determined that organizing the configuration data by ship work authorization boundaries (SWABs) would facilitate such comparison. The SWAB level of identification, as promulgated by NAVSEA Publication 0900-LP-098-6010, dated 6 March 1978, is a four-digit number used to aggregate individual equipments within distinct functional groupings. In general, the SWAB level of identification is used to determine estimating levels for all depot level work orders. It is thus the level of identification within which CMP tasks will ultimately be defined.

As a first step in the organization of the configuration data by SWAB number, a computer sort of APL numbers for LHA-1 Class ships contained in the Type Commander's Consolidated Allowance List (TYCOM COSAL) was obtained. This computer sort provided a sequential list of system names associated with each APL number. System names, which are the same as service application code (SAC) descriptions, were then used to group APL numbers by functional application. The functional application, in conjunction with the nomenclature for each APL number, were aids in the assignment of a "best fit" SWAB number through manual reference to and comparison with SWAB descriptions contained in NAVSEA 0900-LP-098-6010. The purpose of this effort was not to define the entire configuration data base within distinct SWAB groupings, but to create the mechanism whereby selected APL numbers recorded in the MDS and CASREP data base could be identified by SWAB number. PERA (ASC), through concurrent EOC development phase efforts, will ultimately provide the definitive SWAB/APL configuration baseline.

2.3.2 Establish Criticality Criteria

Because the LHA ships are relatively new, and because each ship's documented maintenance history includes corrective maintenance actions reported prior to and during each ship's post shakedown availability (PSA), a significant number of maintenance transactions recorded in the MDS are not related to a malfunction or failure, but rather to such items as the identification of final contract trial (FCT) deficiencies and other items

associated with initial outfitting and furnishing of any new Navy ship. Accordingly, a critical corrective maintenance action (CMA_C) was defined as any corrective maintenance action for which the reported MDS status code was 2 or 3, and for which an expenditure of labor was reported. Status codes, as defined in the *Ships 3-M Manual*, OPNAVINST 4790.4, and used in the reporting of corrective maintenance by fleet personnel, are as follows:

- 1 - Operational
- 2 - Nonoperational
- 3 - Reduced capability
- 4 - Not applicable (e.g., configuration changes and printing services)

The accomplishment of a maintenance action is reported by the use of these status codes to describe the effect of the failure or malfunction on the operational performance capability of an equipment or system when the need for maintenance was first discovered. Use of the codes to categorize an item as maintenance-critical is based on the hypothesis that if status code 2 or 3 is reported, the identified item or some subcomponent or assembly of the item has experienced a malfunction or failure. The nature and cause of the failure are not addressed in this study, but they will be examined during subsequent detailed engineering analyses performed on maintenance-critical systems. To exclude those items (EICs and APLs) for which parts-only actions were reported, a stipulation was invoked whereby an expenditure of labor must have been reported for an item to be designated as maintenance-critical. Parts-only actions were excluded in the identification of maintenance-critical items, because it may be inferred from the absence of a completed maintenance action document that the individual who requisitioned the part did not consider the maintenance action to be significant. While such an inference may or may not be valid, the lack of any completed maintenance action documents applicable to the maintenance action in question largely prohibits useful detailed analysis.

2.3.3 Identify Historical Maintenance Burden

2.3.3.1 MDS Analysis

MDS maintenance transaction data for LHA-1 Class ships were acquired on computer tape from the Navy Maintenance Support Office (NAMSO). The data tape was edited for gross data-field errors and screened for repair applicability (i.e., numeric fields such as man-hours were checked to ensure that all data entries were numeric and that maintenance actions related to the accomplishment of alterations were eliminated). Corrective maintenance actions were then sorted into APL number sequence. This sequential APL list was used to summarize and display selected indicators of the total class maintenance burden for each reported APL number. The total for each maintenance indicator was also displayed. The following principal indicators of maintenance burden were selected for consideration:

- Number of corrective maintenance actions reported
- Number of ship's force man-hours reported

- Number of IMA man-hours reported
- Total number of man-hours reported

The initial APL-sequenced maintenance burden summary list contained all APL numbers actually reported by forces afloat. From the list, it was determined that the MDS data tape contained maintenance transactions for the LHA-1 and LHA-2 ships only, and that the most recent transaction was documented in October 1979. It was also determined that for a significant number of corrective maintenance actions, APL numbers had been reported as unknown or not listed. These corrective maintenance actions were therefore sequentially sorted by reported EIC number.

The next step in the MDS analysis was to determine which of the reported APL and EIC numbers represented critical maintenance items. Accordingly, a second set of maintenance burden summaries was computer-generated. These summaries contained only those APL and EIC numbers for which corrective maintenance actions had been reported with status codes 2 or 3 and an expenditure of labor (see Section 2.3.2). Maintenance burdens associated with these critical maintenance items (APLs and EICs) were summarized as previously described for total maintenance actions.

The critical maintenance actions from the two summaries were individually ranked from highest to lowest total number of man-hours reported. The items that accounted for 75 percent of the total critical maintenance man-hour burden were then categorized as significantly maintenance-critical. All other items were considered to have insufficient data reported to merit further consideration.

Each reported APL and EIC number from the ranked listings of significantly burdened maintenance-critical items was then validated through a review of MDS narrative reports and comparison with configuration data contained in the TYCOM COSAL. Each item was assigned an appropriate level of SWAB identification through the application of the methodology discussed in Section 2.3.1. Identified SWAB numbers were then used to summarize, in SWAB number sequence, the total critical maintenance burden for each SWAB and the subtotal for each SWAB that was attributable to the identified APL or EIC number. The total number of CASREPs attributable to each SWAB and to each item within each SWAB was also displayed and tabulated.

When this summary identification by SWAB of critical maintenance items was completed, a ranked list of identified SWABs was developed. This ranked list was used to display, from highest to lowest total number of man-hours reported, the relative magnitude of the critical maintenance burden from one SWAB to another. Critical maintenance burdens for each SWAB were displayed as an annualized total for each SWAB to facilitate an assessment of the indicated burden and to permit ready comparison with maintenance burden levels derived from other data bases. The annualized total critical maintenance burden was calculated by dividing the total critical maintenance burden for the SWAB by the total ship operating years. The result represented the average annual critical maintenance burden. Ship operating years were calculated as the total number of years the two ships (LHA-1 and LHA-2) had been in commission during the MDS reporting period.

2.3.3.2 CASREP Analysis

CASREP data for LHA-1 Class ships were acquired from the Navy SPCC. The data included all CASREPs prepared by LHA-1 Class ships during the period from commissioning through 5 December 1979.

CASREP data were used to substantiate the criticality of items identified from the MDS as maintenance-critical; i.e., if an item was identified as maintenance-critical, the number of CASREPs recorded against the item was tabulated. This tabulation was then used to assess the impact of malfunctions and failures associated with the item on the ship's ability to fulfill its mission.

Items having a significant number* of CASREPs reported, but an insignificant amount of corrective maintenance, were tabulated and summarized to permit an evaluation of their impact on mission criticality and to determine if any of them should be added to the list of maintenance-critical items to be considered for in-depth engineering analyses.

2.4 REFINE REQUIREMENTS FOR SYSTEMS ENGINEERING ANALYSIS

Systems and equipments that were candidates for engineering analysis (items categorized as maintenance-critical or CASREP-significant) were examined to determine (1) if they represented problems of sufficient magnitude to merit an expenditure of resources, (2) if the indicated problem would be alleviated through the accomplishment of an anticipated alteration, and (3) if the system or equipment had previously been subjected to a maintenance analysis during EOC Program development for another EOC ship class. The shipbuilder's anticipated maintenance burden, as documented and summarized in the LHA-1 Class plans for maintenance,was compared with the actual historical critical maintenance burden derived from the MDS data base. The purpose was to use the shipbuilder's maintenance burden predictions as a basis for determining whether the reported burden represented a problem or a routine expenditure of maintenance resources.

Alterations applicable to the LHA-1 Class, together with other documented technical problems and proposed corrective actions, were then evaluated and compared with identified maintenance-critical items to determine if problems associated with the item had previously been identified by the Navy technical community and if an appropriate corrective action had been identified for accomplishment. To determine if an identified maintenance-critical item had previously been subjected to a maintenance analysis, equipments installed on ships of the LHA-1 Class were identified by APL and the identified APLs were compared with equipment APLs of other EOC ship classes. APLs found to have commonality were then screened through

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*A significant number of CASREPs was considered to be one or more CASREPs per ship operating year (i.e., four or more CASREPs per APL for the LHA-1, and two or more CASREPs per APL for the LHA-2).

a review of published EOC Program maintenance analysis documents. A determination was not made as to whether or not equipment application, installation, environment, and utilization were the same. However, it was assumed that there was sufficient similarity to minimize the necessity for new in-depth maintenance analyses.

Findings resulting from the refinement of engineering analysis requirements were correlated through a subjective evaluation. This evaluation consisted of a selection process whereby an equipment or system was categorized as a candidate for a systems engineering analysis (SEA) if (1) it was experiencing a higher maintenance burden than projected, (2) it was not currently being subjected to a design review or alteration, and (3) it had not previously been subjected to an EOC-oriented maintenance analysis. The degree of each equipment's or system's maintenance criticality was considered by comparing the relative maintenance-critical ranking of one SWAB grouping with that of another and evaluating the number of critical maintenance actions and CASREPs reported. Conclusions were corroborated through a ship visit to the USS SAIPAN (LHA-2) and by PERA (ASC) through a comparative analysis of maintenance burden criticality for functionally similar systems of other ship classes.

2.5 IDENTIFY ALTERATION REQUIREMENTS

Alteration requirements for LHA-1 Class ships were identified from a review of the current fleet modernization program (FMP) as documented in the Navy Ship Alteration Management Information System (SAMIS) data base as of January 1980. Two alteration lists were obtained. The first list, The Amalgamated MIP/TIP (AMT), contained all OrdAlts and title K ShipAlts and reflected the NAVSEA-assigned AMT priority and schedule for accomplishment. The second list, the Type Commander Alteration Matrix (TAM), contained all title D ShipAlts and reflected the Type Commander's priority and schedule for accomplishment.

Because the USS SAIPAN (LHA-2) is the first ship of the class scheduled for implementation of an EOC Program, alterations applicable to the LHA-2 were identified, together with their current status and schedule for accomplishment. Individual LHA-2 alterations categorized by the SAMIS as reliability and maintainability (R&M) improvements were then examined to determine whether or not they were programmed for completion prior to implementation of the EOC Program and to determine their purpose and scope. Alterations applicable to the USS TARAWA (LHA-1) and other ships of the class were also reviewed. However, because of the lead time prior to EOC implementation on these ships, individual ship priorities and schedules were not evaluated.

Available ShipAlt records and the current PERA (ASC) ShipAlt Information Manual (SAIM) were examined to evaluate the purpose and scope of individual alterations. Alterations for which a ShipAlt record was unavailable and for which a description of purpose and scope was not included in the SAIM were subjectively evaluated by considering the assigned functional identification number (FIN) and the brief ShipAlt description provided by the SAMIS and applying engineering judgment. The FIN is a five-digit number

used in the SAMIS data base to identify the functional area and purpose of the alteration. FIN codes ending in 06 are designated as R&M improvements. Each R&M alteration applicable to the USS SAIPAN (LHA-2) was then compared with the list of critical systems and equipments to determine if any alterations not currently programmed for completion prior to implementation of the EOC Program would significantly contribute to a reduction of the maintenance-critical system's or equipment's identified maintenance burden.

2.6 DEVELOP PRE-EOC OVERHAUL REQUIREMENTS

Pre-EOC overhaul requirements are defined by the NAVSEA EOC Program Development Manual as those requirements deemed necessary to return a ship class to an acceptable material condition before its entry into an EOC Program. It therefore follows that for a maintenance item to be categorized as a pre-EOC overhaul requirement, there must be a significant amount of material degradation as measured from an identifiable baseline condition.

Because the LHA-1 Class ships are essentially new, and because each, with the exception of the USS TARAWA (LHA-1), is projected to enter the EOC Program concurrently with the completion of its first regular overhaul (ROH), it was anticipated that few, if any, systems will have deteriorated to a level that would mandate the accomplishment of a baseline overhaul; i.e., these ships are currently in or near their baseline condition. The only available LHA-1 Class data from which deterioration of material condition may readily be determined are the historical service life data (MDS and CASREP) described in Section 2.3 for the identification of maintenance-critical systems and equipments. Accordingly, these data were reviewed to determine if the amount of reported maintenance represented a significant deterioration of the system's or equipment's like-new material condition. This determination was made by considering the number of maintenance actions or CASREPs reported and by reviewing the MDS and CASREP data narratives.

CHAPTER THREE

RESULTS

As a result of this study, LHA-1 Class EOC Program development phase requirements were revised to reflect current objectives and constraints, and various elements of LHA-1 Class engineering and maintenance data were collected and reviewed. Analysis of the available data resulted in the identification of maintenance-critical systems and equipments most significant in terms of the historical maintenance burden compiled by forces afloat.

Each identified maintenance-critical system and equipment was examined to determine if it represented a large enough maintenance burden to be categorized as a problem, if the problem was currently being corrected through an alteration or other pending technical action, and if the system or equipment had previously been subjected to an engineering analysis because of commonality with another EOC ship class. This effort resulted in the refinement of the list of maintenance-critical systems and equipments, the identification of alteration requirements, and the identification of candidates for future in-depth SEAs. In addition, pre-EOC overhaul requirements were evaluated on the basis of the available data, resulting in the conclusion that LHA-1 Class ships may be entered into an EOC Program without undergoing a baseline overhaul.

This chapter, supplemented by the appendixes, provides a compilation of the results and findings of this study.

3.1 DEVELOPMENT PHASE REQUIREMENTS AND POA&M

Current LHA-1 Class EOC Program development phase requirements are reflected in the POA&M presented in Figure 3-1. This POA&M, which identifies the engineering and planning actions required for the development phase effort, was derived from the preliminary POA&M developed for the amphibious EOC Program during the program initiation phase completed in June 1978. The POA&M has been updated to reflect the status of current development phase tasks. Individual task schedules are consistent with current funding constraints and the overhaul commencement date for LHA-2. Tasks 1 through 6 are as described in this report, tasks 7 through 10 are currently in progress, and the rest of the tasks have not begun.

Task	Description
1	Update POA&M
2	Collect Ship Class Data
3	Determine Alteration Requirements
4	Determine Pre-EOC Overhaul Requirements
5	Upgrade Identification of Maintenance-Critical Systems and Equipments
6	Refine System Engineering Analysis (SEA) Requirements
7	Develop EOC Program Management Plan (PMP)
8	Define SEA Methodology
9	Identify Documented Off-Ship Maintenance Tasks
10	Update and Expand Common Configuration Class List
11	Conduct SEAs
12	Develop Pre-EOC Overhaul Ship Alteration Repair Package (SARP) for First Ship of Class
13	Develop Class Maintenance Plan (CMP)
14	Develop Material Condition Monitoring and Assessment Procedures
15	Accomplish Pre-EOC Overhaul Planning
16	Develop EOC Program Effectiveness Procedures
17	Develop Management Information System (MIS)
18	Implement EOC Program MIS
19	Conduct First Pre-EOC Overhaul
20	Translate CMP into Individual Ship Plans
21	Establish Central Technical Group
22	Establish Site Teams
23	Enter CMP Items into MIS
24	Start Implementation Phase

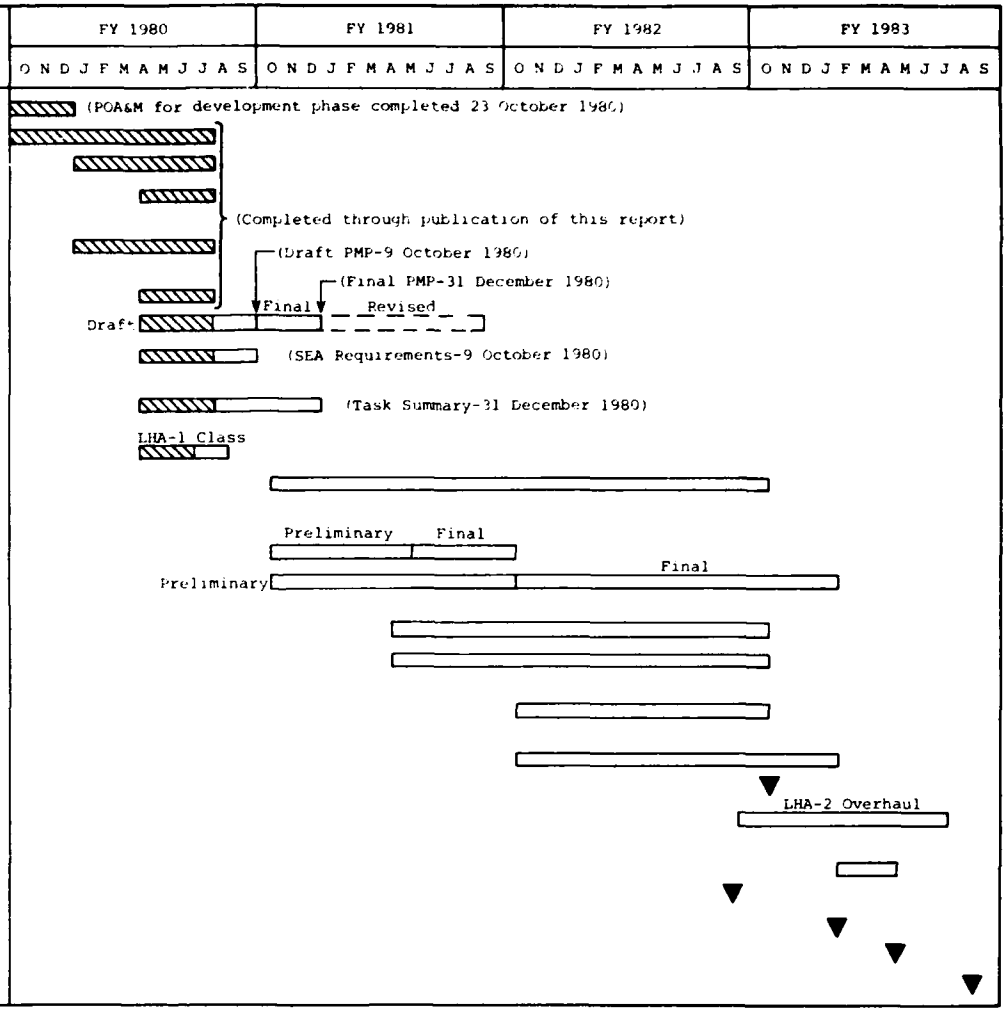

Figure 3-1. CURRENT PLAN OF ACTION AND MILESTONES (POA&M) FOR LHA-1 CLASS EOC PROGRAM DEVELOPMENT PHASE REQUIREMENTS

Specifics of each development phase task are described in the NAVSEA *EOC Program Development Manual*. However, because the LHA-1 Class is a new class of ship, and because only limited historical data are available from which EOC Program maintenance requirements may be derived, additional criteria and guidance are being developed. This guidance will in part be a product of Tasks 7 and 8 (development of the EOC Program management plan and definition of the systems engineering analysis methodology). Further refinement will be achieved as more tasks are begun.

3.2 DATA COLLECTION

As discussed in Section 2.2, data appropriate to the EOC development phase effort were collected to the extent necessary to support current and near-term requirements. Appendix A describes the detailed engineering and maintenance data for the LHA-1 Class collected or identified for procurement as a result of this study.

Because LHA-1 Class ships have compiled only a limited maintenance history from which long-range maintenance requirements can be projected, it is anticipated that the final development of an EOC maintenance strategy will rely heavily on design data compiled by the shipbuilder and other data compiled by Navy activities currently attempting to resolve identified LHA-1 Class technical problems and design deficiencies. In keeping with this philosophy, a considerable quantity of design data has been obtained, and more data are being acquired. This effort will ultimately result in the compilation of a repository of EOC Program information not now centrally available in the Navy.

It is expected that future systems engineering analysis requirements will require the selective procurement of data yet to be defined. Data such as selected blueprints and technical manuals will be required, but compilation of a comprehensive library of such documents solely for EOC development would not be cost-effective or practical, because of the volume of data involved. Data collected to date, together with those currently projected for near-term acquisition, are such that a controlled library and accession list should be established.

3.3 MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS

3.3.1 MDS Summary

As discussed in Section 2.3, a list of maintenance-critical systems and equipments was developed from the historical maintenance data produced by the LHA-1 and LHA-2. Maintenance data applicable to the other three ships of the class were not available. Systems and equipments identified as maintenance-critical accounted for 78 percent of the total critical maintenance man-hours reported from May 1976 through October 1979. Table 3-1 is a summary of the organizational and intermediate level corrective maintenance burdens for the two reporting ships of the class.

Table 3-1. SUMMARY OF LHA-1 CLASS CORRECTIVE MAINTENANCE, MAY 1976 THROUGH OCTOBER 1979

Parameter	Maintenance Effort		
	Organizational Level	Intermediate Level	Total
Total corrective maintenance man-hours	333,074	55,045	388,119
Percentage of total reported corrective maintenance man-hours attributed to critical maintenance actions	53	30	50
Total critical corrective maintenance man-hours	178,472	16,345	194,817
Percentage of total reported critical corrective maintenance man-hours attributed to maintenance-critical systems and equipments	78	77	78

Analysis of the maintenance data determined that corrective maintenance actions had been reported against 4,003 APL numbers. In addition, for approximately 29 percent of the total corrective maintenance actions, the APL number had been reported as unknown or not listed. These latter corrective maintenance actions were sequentially sorted by reported EIC number. Table 3-2 is a summary of MDS maintenance burden indicators for the LHA-1 Class.

The next step in the analytical process was to determine which of the reported APL and EIC numbers represented critical maintenance items. Accordingly, a second set of maintenance burden summaries was computer-generated. From these summaries, it was determined that critical maintenance actions had been reported against 2,114 APL numbers (53 percent of the total APL numbers reported) and 523 EIC numbers (64 percent of the total EIC numbers reported). A class summary of MDS critical maintenance burden indicators is presented in Table 3-3.

The maintenance burden indicators of these two summaries were then individually ranked from highest to lowest total number of man-hours reported. From this ranking, it was determined that all items with a total reported critical maintenance burden of 100 man-hours or greater could be accounted for by 280 APL numbers and 95 EIC numbers from the highest ranks. Collectively, these items accounted for 78 percent of the total critical maintenance man-hours and 55 percent of the total critical maintenance actions. All other APL and EIC numbers were considered to have insufficient data reported to merit further detailed analysis and were therefore excluded

from further consideration. A class summary of MDS critical maintenance burden indicators for items with 100 or more man-hours reported is presented in Table 3-4.

Table 3-2. LHA-1 CLASS SUMMARY OF MDS MAINTENANCE BURDEN INDICATORS

Source of Maintenance Burden Indicators	Corrective Maintenance Actions (CMA)	Man-Hours		
		Ship's Force	IMA	Total
From summary of 4,003* reported APL numbers	21,530	219,252	26,589	245,841
From summary of 813* reported EIC numbers where APL number was not reported	8,772	113,822	28,456	142,278
Total	30,302	333,074	55,045	388,119

*These quantities represent the actual number of APLs and EICs reported; they are not validated levels of identification.

Table 3-3. LHA-1 CLASS SUMMARY OF MDS CRITICAL MAINTENANCE BURDEN INDICATORS

Source of Critical Maintenance Burden Indicator	Critical Corrective Maintenance Actions (CMA_C)	Man-Hours		
		Ship's Force	IMA	Total
From summary of 2,114* reported APL numbers	9,269	139,967	11,454	151,421
From summary of 523* reported EIC numbers where APL number was not reported	2,780	38,505	4,891	43,396
Total	12,049	178,472	16,345	194,817

*These quantities represent the actual number of APLs and EICs reported; they are not validated levels of identification.

Table 3-4. LHA-1 CLASS SUMMARY OF MDS CRITICAL MAINTENANCE BURDEN INDICATORS FOR ITEMS WITH 100 OR MORE MAN-HOURS REPORTED

Source of Critical Maintenance Burden Indicator	Critical Corrective Maintenance Actions (CMA_C)	Man-Hours		
		Ship's Force	IMA	Total
From summary of 280* top-ranked APL numbers	4,883	108,241	8,575	116,816
From summary of 95* top-ranked EIC numbers	1,719	31,594	4,019	35,613
Total	6,602	139,835	12,594	152,429

*These quantities represent the actual number of APLs and EICs reported; they are not validated levels of identification.

Each reported APL and EIC number from the ranked lists of significantly burdened maintenance-critical items was then validated and assigned an appropriate level of SWAB identification. The 280 APL numbers were validated by comparing each with the TYCOM COSAL APL listing. If a direct correlation was found, the APL number was accepted as valid. Where a correlation could not be established, the complete set of MDS narrative reports (reproductions of the original maintenance transaction documents) were reviewed to determine what the reported APL number should have been. Each validated APL number was then assigned an appropriate level of SWAB identification through the application of the methodology discussed in Section 2.3.1.

The 95 EIC numbers were also validated. This validation was more general than that for the APL data; it consisted only of a review of the MDS narrative reports. The review identified equipments that constituted the bulk of the critical maintenance actions reported against the EIC and facilitated categorization of the EIC by SWAB.

During the validation process, it was determined that some EICs should not be categorized as maintenance-critical. These were related to such items as miscellaneous furnishings, equipage, administration, and support services. In addition, some APLs were found to have reported expenditures of man-hours that were inconsistent with the maintenance action described. These distortions of the data base were corrected by either totally eliminating the item from consideration or adjusting the number of man-hours reported to reflect more accurately the maintenance action described. These adjustments reduced the number of critical maintenance actions by approximately 1 percent and the number of critical maintenance man-hours by

approximately 14 percent. The number of APLs was also reduced. Appendix B presents a list, in SWAB order, of validated MDS critical maintenance burden indicators for items having 100 or more man-hours reported.

Upon completion of the summary of critical maintenance items, a ranked list of identified SWAB numbers was developed. This list was used to compare, from highest to lowest total number of man-hours reported, the critical maintenance burden of one SWAB number with another. Critical maintenance burdens for each SWAB number were displayed as an annualized total to facilitate an assessment of the indicated burden and to permit ready comparison with maintenance burden levels derived from other data bases. The annualized total critical maintenance burden was calculated by dividing the total critical maintenance burden for the SWAB by the total number of ship operating years. Ship operating years were determined to be the total number of years the two ships (LHA-1 and LHA-2) had been in commission during the MDS reporting period (3.4 years for the LHA-1, and 2 years for the LHA-2). Appendix C contains the ranked list of maintenance-critical systems by SWAB. It shows that the three most significant contributors, by SWAB, to the LHA Class critical maintenance man-hour burden are the height finding radar (2,678 critical maintenance man-hours per ship operating year), the firemain and flushing piping system (1,448 man-hours), and the automated propulsion control system (1,377 man-hours).

As identified in Appendix B, the maintenance burden for the height finding radar is primarily attributable to four individual equipments associated with the AN/SPS-52B radar. The firemain and flushing system burden is attributable to valves and piping system components, with a significant portion of the burden reported against various sizes of butterfly valves. The automated propulsion control system, which has been broadened in this report to include the main and auxiliary ship's service turbine generator controls, has a long-recognized class maintenance problem and is currently scheduled for major modification.

3.3.2 CASREP Summary

From May 1976 through 5 December 1979, the USS TARAWA (LHA-1) produced 677 CASREPs, and the USS SAIPAN (LHA-2) produced 214. Of these 891 CASREPs, 460 were identified and tabulated as having been reported on items previously identified and categorized as maintenance-critical through the analysis of MDS data. Table 3-5 lists the top 20 systems and equipments, ranked according to critical maintenance man-hour burden, together with the number of associated CASREPs.

As indicated in the table, of the 460 CASREPs prepared on maintenance-critical systems, 230 (50 percent) concerned these 20 systems. Accordingly, these systems have not only required the largest expenditure of man-hours, but have also accounted for a significant portion of failures or malfunctions that resulted in a loss of mission capability.

Other systems and equipments on which a significant number of CASREPs were prepared, but which were not identified as maintenance-critical, were also tabulated. Twenty-two APLs within 14 SWAB groupings were identified

Table 3-5. TOP 20 MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS FOR LHA CLASS SHIPS

Rank	SWAB Number	Nomenclature	Number of CASREPs
1	453-1	Height Finding Radar	8
2	521-1	Firemain and Flushing System (Piping)	2
3	252-1	Automatic Propulsion Control, Including Main and Auxiliary Ship Service Turbine Generators (SSTG)	10
4	432-1	Telephone Systems	0
5	495-3	Tactical Support Center, Special Purpose Intelligence System	24
6	423-1	Electronic Navigation	16
7	555-1	Fog Foam and AFFF	12
8	529-3	Ballast/Deballast System (Piping)	7
9	436-1	Alarm, Safety, and Warning Systems	1
10	589-2	Bridge and Other Moving Cranes	4
11	221-1	Propulsion Boilers	33
12	434-1	Entertainment and Training TV	0
13	573-4	Fork Lift Trucks	23
14	440-4	Message Processing Distribution System	11
15	437-1	Indicating, Order, and Metering Systems	3
16	312-1	Emergency Diesel Generator Set	9
17	481-1	Gunfire Control Systems	18
18	441-5	Communications Transceivers	44
19	167-1	Watertight Doors, Hatches, and Scuttles	4
20	431-1	IC Switchboards	1
		Total	230

as having one or more CASREPs per ship per year. Appendix D contains a list in SWAB sequence of these APLs, together with a summary of the number of critical maintenance actions, man-hours, and CASREPs. Table 3-6 lists the 14 SWAB groupings, together with the number of CASREPs.

Table 3-6. SYSTEMS AND EQUIPMENTS WITH CASREPs REPORTED, BUT NOT IDENTIFIED AS MAINTENANCE-CRITICAL

SWAB Number	Nomenclature	Number of CASREPs
255-5	Main Condensate Pump	2
261-2	Fuel Oil Service Pumps	4
437-1	Indicating, Order, and Metering Systems	2
440-4	Message Processing Distribution System	11
441-1	Communications Antenna Systems	15
441-3	Communications Transmitters	34
441-4	Communications Receivers	4
441-6	Remote Communications Devices	28
481-1	Gunfire Control Systems	2
542-1	Aviation and General Purpose Fuel Systems	4
583-1	Boat Handling and Stowage	3
589-2	Bridge and Other Moving Cranes	7
711-1	Guns and Mounts	4
721-1	Missile Launching System	2
	Total	122

3.4 FINDINGS RELATED TO REFINEMENT OF ENGINEERING ANALYSIS REQUIREMENTS

3.4.1 Maintenance Burden Predictions

Maintenance-critical systems and equipments as identified in Appendix B were compared with the shipbuilder's PFM documents to determine if the reported critical maintenance burden had been predicted by the shipbuilder and, by inference, if the requisite logistics resources had been adequately defined.

The shipbuilder's predicted maintenance burden for LHA-1 Class systems and equipments is contained in each ship's plan for maintenance (PFM) documents. There are 40 hull, mechanical, and electrical (HM&E) and ordnance PFMs and 10 electronics PFMs. Each PFM is a aggregation or summary of maintenance engineering analyses (MEAs) prepared by the shipbuilder. The primary purpose of the PFM is to identify and describe the logistic resources required to provide maintenance support to ships of the class.

Each PFM document includes, for each listed system or equipment, predicted corrective maintenance tasks, the predicted frequency of occurrence, and the predicted number of man-hours required for the performance

of the task. In addition, each PFM provides a summary of the average annual man-hour requirement for the accomplishment of all tasks listed in the PFM.

Ideally, when the actual historical maintenance burden of an equipment is compared with maintenance burden predictions, any difference should indicate a potential maintenance problem. However, because of differences between the PFM and MDS data bases, such a direct comparison is not feasible without in-depth engineering analyses. In the case of MDS data, only certain maintenance-significant actions are reported for a given equipment, whereas the PFM contains all predicted maintenance actions (for example, replacement of a gasket or a light bulb would not normally be reported in the MDS, but the prediction for such an action would be contained in the PFM). Other differences in the data bases are related to the level of system or equipment maintenance task identification. The PFM generally provides maintenance burden predictions at subcomponent levels within an APL; these predictions are then summarized as a collective burden for all equipments in the PFM. The MDS data, on the other hand, are reported at an EIC or APL level of identification. Because a definitive comparison would have required reconciliation of these differences, and because the effort involved exceeded available resources, more general comparisons were made.

The first comparison between the two data bases revealed that during the 5.4 years covered in the MDS data, the two reporting ships accumulated an average annual ship's force labor burden of approximately 62,000 man-hours for all reported maintenance actions, whereas the PFM predicted more than 83,000 man-hours. Thus, the actual labor burden appears to have been well under that which had been predicted. As previously discussed, the number of critical maintenance actions resulting from failure or malfunction was substantially lower than the predicted total (approximately 33,000 reported man-hours, or less than 40 percent of the predicted total). This apparent overestimation is explained by the fact that the ships are not required to provide a report of all corrective maintenance actions performed. Therefore, each system or equipment has most likely experienced additional, unreported maintenance that, if reported, would substantially change the difference between the predicted and historical labor burdens.

The second comparison of the data bases compared the critical maintenance man-hour burdens with PFM maintenance burden predictions by combining and reordering the various SWAB groups to conform with the PFM level of identification; i.e., if a given PFM document included more than one SWAB group of systems and equipments, all maintenance-critical SWAB groups associated with the PFM were combined, and the total number of man-hours reported was used for comparison. This was done under the hypothesis that although the MDS data base reflected a smaller labor burden than predicted, individual PFMs could contain equipments that exhibited a larger labor burden than predicted for all systems and equipments.

As anticipated, this comparison resulted in the identification of 13 PFMs for which the reported critical maintenance man-hour burden exceeded that predicted for all maintenance tasks described in the PFM boundary. Table 3-7 lists these PFMs and their man-hour differences. The MDS data

base reflects a smaller labor burden than predicted, and the annual man-hours tabulated in Appendix C for maintenance-critical systems and equipments account for less than the total reported labor burden. Therefore, any items that are identified as maintenance-critical and whose labor burden exceeded individual PFM maintenance predictions may be categorized as maintenance problems.

Table 3-7. PFMs WITH APPARENT MAN-HOUR DEFICIENCIES

PFM	Title	Rank	Predicted Man-Hours (PFM)	Actual Man-Hours (MDS)	Man-Hour Difference
LLA-408	Surveillance System	1	1,863	2,828	-965
E-52	Damage Control	2	49	954	-905
F-69	Hull and Hull Fitting	3	203	818	-615
B-12	Ship Service/ Emergency Power	4	476	1,025	-549
D-34	Ship Control and Steering	5	63	500	-437
D-33	Ballast System	6	337	758	-421
C-22	IC Systems	7	587	974	-387
LLA-410	Electronic Navigation	8	397	779	-382
LLA-402	Gunfire Control	9	72	379	-307
A-01	Boilers	10	339	562	-223
E-48	Saltwater System	11	1,555	1,780	-225
F-10	Deck Equipment	12	459	604	-145
J-76	Ship Shops	13	215	299	-84
Total					-5,645

In addition to the PFMs identified as exhibiting man-hour deficiencies, four SWAB groups of maintenance-critical systems and equipments were identified that did not appear to be reflected in any PFM. These SWAB groups, which accounted for 3,308 critical maintenance man-hours, are listed in Table 3-8.

These apparent deficiencies in PFM man-hour predictions do not represent a true difference. The total MDS man-hour burden used in the comparison is for only a portion of the total number of systems and equipments described in each document. In addition, the MDS man-hour burden reflects only the portion of the total burden categorized as maintenance-critical. The comparison shows that the PFM prediction appears to have been inadequate. The degree of inadequacy is probably much greater than indicated, particularly for those maintenance-critical items used in the comparison.

Table 3-8. CRITICAL SYSTEMS AND EQUIPMENT NOT INCLUDED IN EXISTING PFM PREDICTIONS

SWAB Number	Nomenclature	Man-Hours (MDS)
421-1	Non-Electrical/Electronic Navigation Systems	787
511-1	Heating Systems	1,120
526-1	Deck Drains	1,244
640-1	Berthing, Leisure, and Community Spaces	157
	Total	3,308

3.4.2 Alteration Requirements

All LHA-1 Class alterations, both programmed and unprogrammed, were reviewed to determine if any alteration could be expected to have a significant impact on any system or equipment identified as maintenance-critical. This was accomplished by identifying the SWAB groups of maintenance-critical systems and equipments affected by maintenance-significant alterations. Each maintenance-significant alteration was then evaluated relative to individual systems and equipments in the maintenance-critical SWAB group. Alterations identified as having significant impact on maintenance-critical items are listed in Table 3-9.

Table 3-9. LHA-1 CLASS ALTERATIONS HAVING SIGNIFICANT IMPACT ON MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS

SWAB Number	ShipAlt	ShipAlt Brief
252-1	165K	Replace Automatic Propulsion Control System
423-1	127K	Replace AN/URN-4 UHF Direction Finder
423-1	128K	Replace AN/URN-20 TACAN Antenna
453-1	133K	Replace AN/SPS-52B Radar
516-1	200D	Replace 10-Ton Air Compressor
529-4	153K	Replace Deballast Air Compressor
551-5	210K	Replace LP Air Compressor
570-0	256K	Improve Assault System Reliability
521-1	214K	Replace 12" Firemain Butterfly Valves

Other alterations having potential for improving reliability and maintainability were also identified, but none appeared to be relevant to the systems and equipments categorized as maintenance-critical. A concise assessment of these additional alterations and their impact on maintenance burden is not feasible without an in-depth analysis of all relevant maintenance data and the scope of each alteration. In general, this preliminary review of the alteration package indicates that currently scheduled ShipAlts have a negligible impact on EOC Program development.

Class items, warranty items, open Part I inspection and survey (INSURV) items, and open technical problems relevant to LHA-1 Class ships were identified from the USS SAIPAN (LHA-2) transfer book dated 31 March 1979. This document, which originated with the Ship Acquisition Procurement Manager (SHAPM) (NAVSEA PMS-377), provided for transfer of management responsibility of the LHA-2 to NAVSEA 941. NAVSEA PMS-377 retained technical responsibility for applicable technical issues until satisfactory corrective actions could be identified and reported to NAVSEA 941. These technical problems were considered in the context of alterations, because in general, resolution of open technical problems involves the accomplishment of an alteration or an equivalent action.

A composite listing of all LHA-1 Class items for each ship of the class was identified from an LHA-1 Class Item Status Matrix Report dated 4 January 1980. This document, which was provided by PERA (ASC), was used to determine the current status of each class item on the LHA-2 and was also used as an index of class items applicable to other ships of the class. Of the 677 class items contained in the matrix report, several were identified as having potential for improving reliability and maintainability. Some have been corrected during PSA, others have been incorporated as alterations, and the rest remain open. All class items potentially relating to the enhancement of reliability and maintainability were compared with the systems and equipments identified as maintenance-critical. No class items were found to have a significant impact on EOC development except those incorporated as alterations and the following:

- Class item 1077 is related to supply support of the Internal Voice Communication System (IVCS) terminals. This item is listed as open technical problem CSO-006 in the LHA-2 turnover document. CSO-006 has been corrected on hulls 3 through 5, but for LHA-1 and LHA-2, the proposed action is to replace the IVCS terminals with redesigned units on a reorder or depot repair basis.
- Technical problem DC-004 is related to unsatisfactory reliability of the AFFF foam proportioners. The proposed solution here is the development of a ShipAlt to replace the proportioners.

If these open technical problems are not resolved, they may consume an inordinate amount of maintenance resources; if they are not corrected prior to EOC implementation, they could affect the ability of ship's forces to maintain other systems and equipments.

3.4.3 EOC Ship Class Commonality

The TYCOM COSAL data were sorted to compare APLs listed for LHA Class ships and the following EOC ship classes:

DDEOC/LO-MIX	PEOC
DD-963	LPH-2
DDG-37	LPD-4
FF-1052	LSD-36
CG-16	LST-1179
CG-26	LKA-113
FFG-7	

LHA Class APLs were compared with those of the DDEOC/LO-MIX ship classes to identify any common equipments previously subjected to an in-depth maintenance analysis and to identify an additional source of relevant historical information for equipments not previously subjected to in-depth analysis. Similarly, comparisons were made with prospective amphibious EOC (PEOC) ship classes to identify additional sources of historical data. A comparison was also made between APLs common to LHA and DDEOC and APLs common to LHA and PEOC to identify those uniquely common to other PEOC ship classes. This was to identify equipments that have not been analyzed in the EOC Program, but which, if subjected to in-depth maintenance analysis, could result in benefits for PEOC ships in addition to the LHA class.

This APL commonality comparison identified 6,341 APLs applicable to LHA Class ships (LHA-1 or LHA-2). Of these, 2,257 APLs were identified as having commonality with one or more ships of the DDEOC/LO-MIX ship classes, and 2,194 APLs were identified as having commonality with other PEOC ship classes. Four hundred seventy-six APLs were identified as uniquely common to PEOC ships. Thus, 2,733 APLs (43 percent of the total LHA Class APLs) were identified as having commonality with other EOC ship classes.

Equipment APLs having commonality with other EOC ship classes were then compared with maintenance-critical APLs. Of the 260 maintenance-critical APLs, 63 were identified as having commonality with the DDEOC/LO-MIX classes. In addition, 7 CASREP-significant APLs were found to have commonality with the DDEOC/LO-MIX classes. Of these 70 maintenance-critical/CASREP-significant APLs, 32 were identified as having been subjected to a DDEOC/LO-MIX maintenance analysis, and 17 were identified as having unique commonality with other PEOC ship classes. Thus, of 260 equipment APLs identified as maintenance-critical and 22 equipment APLs identified as CASREP-significant but not maintenance-critical, 87 (31 percent) were found to have commonality with other EOC ship classes. A detailed list of these common APLs is contained in Appendix E. APLs previously subjected to an in-depth maintenance analysis are indicated in the appendix.

To determine if a previous in-depth maintenance analysis had been accomplished as indicated in Appendix E, systems maintenance analysis (SMA) publications prepared for NAVSEA under the DDEOC Program were reviewed, as well as an index of logistics support analyses (LSAs) prepared for NAVSEA under the FFG-7 LO-MIX Program. Comparisons were made at the APL level, and if APL commonality was established, it was concluded that the identified equipment had been subjected to analysis. While it is not known if the equipment application, installation, environment, and utilization are the same for the LHA Class as for the other DDEOC/LO-MIX ship classes, it is assumed that there is sufficient similarity to minimize the necessity for new in-depth maintenance analyses.

3.4.4 Correlation of Findings

Findings regarding maintenance burden predictions, alteration requirements, and EOC ship class commonality were correlated by considering whether the maintenance-critical/CASREP-significant item appeared in an excessively burdened PFM, whether its maintenance burden would be significantly affected by an identified alteration, and whether the item had previously been subjected to a DDEOC/LO-MIX engineering analysis. If a system or equipment had been previously analyzed in another EOC Program, it was dropped from further consideration. Alteration significance was determined by evaluating the anticipated scope of the alteration and the types of maintenance actions reported. Where the alteration appeared to have a clear probability of alleviating the reported maintenance burden, the associated items were eliminated from further consideration.

MDS and CASREP data narratives were reviewed for maintenance-critical items within the 13 excessively burdened PFMs from Table 3-7 (except for those items eliminated due to alteration impact or previous EOC analysis). The 20 top-ranked maintenance-critical SWAB groupings were reviewed in depth, and other items were evaluated as to the reported critical maintenance actions and number of CASREPs reported. The results of this subjective evaluation were then corroborated through a ship visit to the USS SAIPAN (LHA-2) and by PERA (ASC) through a comparative analysis of maintenance burden criticality for functionally similar systems of other ship classes. To determine which systems or equipments should be considered as candidates for in-depth engineering analysis, some were combined and considered collectively, and others were subdivided into equipment segments. Table 3-10 lists systems and equipments that were determined to be desirable candidates for in-depth analysis, together with a brief statement of the rationale for the selection of each.

Systems and equipments identified in Table 3-10 were compared with the systems identified as maintenance-critical during the LHA-1 Class EOC Program initiation phase to determine if a correlation existed.

As indicated in Table 3-11, one additional system, the ventilation system, was added to the list of maintenance-critical systems identified by the initiation phase study. It was added primarily as a result of a visit to the USS SAIPAN (LHA-2) and has been included as a candidate because of a major problem attributed to maintenance of vent motors. Although only three vent motors (see Appendix B, SWAB 512-1) were identified

Table 3-10. LHA-1 CLASS SYSTEMS AND EQUIPMENTS SELECTED AS CANDIDATES FOR IN-DEPTH SYSTEMS ENGINEERING ANALYSIS (SEA)

PFM	3M/AB Number	System or Equipment	CMA_C Rank	Number of CASREPs	Rationale
C-19 C-22		Damage Control Monitoring Systems Interior Communications Systems			High collective man-hour burden. Man-hour prediction for PFM C-22 appears to have been inadequate. Five of the 20 top-ranked systems related to CMA_C man-hours are interior communications systems. Ship visit to USS SAIPAN (LHA-2) categorized the IC work center as the most critically burdened of all engineering department work centers.
	432-1	• Telephone Systems	4	6	
	436-1	• Alarm, Safety, and Warning Systems	9	1	
	434-1	• Entertainment, Training, and TV Systems	12	0	
	437-1	• Indicating, Order, and Metering Systems	15	3	
	431-1	• Internal Voice Communication System (IVCS) switchboard and Equipments	20	0	
	433-1	• Announcing Systems	47	0	
	435-1	• Tank Level Indicating System	74	0	
F-48 D-11		Saltwater Systems Ballast Systems			High collective man-hour burden. Man-hour predictions for PFMs appear to have been inadequate. Responsible work centers (A&R Divisions) categorized by USS SAIPAN (LHA-2) as second only to electrical work centers as most critically burdened area in the engineering department.
	511-1	• Firemain and Flushing System (Piping and Valves)	2	4	
	511-2	• Firemain and Flushing System (Pumps)	4	3	
	522-1	• Sprinkler System	50	2	
	523-1	• Counterpressure Washdown System	100	1	
	524-1	• Ballast/Deballast System (Piping)	8	2	
F-44		Hull and Hull Fitting			High collective man-hour burden. PFM appears to have been inadequate. Categorized as a major maintenance problem by USS SAIPAN (LHA-2) and by COMPHIBRON Eight material officer.
	167-1	• Watertight Doors, Hatches, and Scuttles	14	4	
	164-1	• Non-Structural Doors	75	0	
	111-	• Miscellaneous Other 3M/AB Applicable, Including Preservation and Painting	-	-	
H-61 H-41		Aircraft Handling Assault Systems			Severe maintenance problem as evidenced by number of CASREPs, man-hour burden, and reported experience of chief engineer, USS SAIPAN (LHA-2).
	744-1	• Aircraft Elevators	27	17	
	744-2	• Aircraft Cranes	57	8	
	743-	• Monorail Systems	10	4	
	747-4	• Fork Lift Trucks	13	3	
D-48		Ventilation Systems			High man-hour burden. Vent motors categorized as a major maintenance problem by USS SAIPAN (LHA-2), with electric motors in general considered to be the single most severe maintenance problem in an overloaded work center.
	311-1	• Vent Motors and Controls	21	2	
	311-1	• Heating Systems	31	0	
LLA-4[illegible]		Radio Communications Systems			High man-hour and CASREP burdens. Collins radios categorized by USS SAIPAN (LHA-2) as number one maintenance problem in electronics area.
	44[illegible]-4	• Message Processing Distribution System	14	11	
	441-5	• Communications Transceivers	18	44	

Table 3-11. CORRELATION OF SEA CANDIDATES WITH THE RESULTS OF THE LHA-1 CLASS INITIATION STUDY

System	Initiation Study Candidate	Current Candidate
Radio Communications and ITAWDS	Yes	Yes
Aircraft Handling and Assault Systems	Yes	Yes
Ballast and Saltwater Systems	Yes	Yes
Surveillance Systems and Waveguides	Yes	No
Guided Missile Fire Control System	Yes	No
Deck Equipment	Yes	No
Compressed Air and Gas	Yes	Nc
Damage Control Monitoring and Interior Communications Systems	Yes	Yes
Hull and Hull Fittings	Yes	Yes
Ventilation and Heating Systems	No	Yes

from the MDS data as maintenance-critical, the Chief Engineer of the USS SAIPAN (LHA-2) reported that the biggest single recurring maintenance problem was that of electric motors. A lack of qualified personnel and shop facilities severely limited motor overhaul capability -- the electrical division was undermanned, and the motor maintenance workload was increasing. Because of the large number of vent motors installed on each ship of the class, and because the shipbuilder's maintenance strategy generally calls for electric motors to be overhauled at the organizational level, it is expected that a redefinition of the maintenance strategy and associated logistics support may be required.

Heating systems were included in the boundaries for analysis because they do not appear to have been included in the shipbuilder's PFM projections, they are generally related to the vent system, and selected heating system equipments were identified as maintenance-critical.

The following systems are not currently considered to be SEA candidates for new engineering analyses as a result of this study:

- Surveillance Systems -- Eliminated because of alteration impact and commonality of equipments with those subjected to previous DDEOC/LO-MIX maintenance analyses.
- Guided Missile Fire Control System -- Eliminated because of small reported maintenance burden and commonality of equipments with those subjected to previous DDEOC/LO-MIX maintenance analyses.

- Deck Equipment -- Critical maintenance burden not indicative of a significant maintenance problem.
- Compressed Air and Gas -- Eliminated because of alteration impact and small reported maintenance burden.

Thus, as indicated, five of the six systems currently categorized as SEA candidates were previously identified by the initiation study as maintenance-critical. This study, however, has gone further than the initiation study in that specific equipments have been identified for the focus of SEA efforts. Suitability of these systems as SEA candidates was further corroborated by PERA (ASC) through consideration of factors independent of the process and data by which these systems were selected. Corroboration consisted of a comparative analysis of maintenance burden criticality for functionally similar systems as reflected within the following:

- DDEOC maintenance-critical systems/equipments lists for the DDG-2, DDG-37, and FF-1052 ship classes
- DDEOC system maintenance analyses (SMA) documents
- PEOC maintenance-critical systems/equipments lists from the PEOC initiation study for the LST-1179 and LPD-4 ship classes
- LHA-1 Class PSA/RAV work package summaries

This comparative analysis by PERA (ASC) developed the ranked list of potentially maintenance-critical LHA-1 Class systems in Table 3-12.

Table 3-12. LIST OF POTENTIALLY MAINTENANCE-CRITICAL LHA-1 CLASS SYSTEMS RANKED BY PERA (ASC)

Rank	System/Equipment
1	Firemain and Flushing Systems
2	Cargo Handling Systems
3	Structural Closures
4	Propulsion Boilers
5	Telephone Systems
6	Entertainment, Training, and TV Systems
7	Radio Systems
8	Miscellaneous Handling Systems
9	Ventilation Systems
10	Switchboards (IC Systems)
11	Alarm, Safety, and Warning Systems
12	Indicating, Order, and Metering Systems
13	Exterior Communications Systems
14	Gun Fire Control Systems
15	Sprinkler Systems
16	Ballast/Deballast Systems
17	Aircraft Handling Service Systems

Of the 17 systems and equipments identified in Table 3-12, 15 are also included in the list of SEA candidates in Table 3-10. Accordingly utilization of the results of PFM/MDS comparisons for selection of SEA candidates was substantiated. The propulsion boilers and gun fire control systems were included in the PERA (ASC) list of potentially maintenance-critical LHA-1 Class sytems but were not included in Table 3-10. They were addressed during the ship visit to the USS SAIPAN (LHA-2) previously discussed and were categorized as not being significant maintenance problems.

3.4.5 SEA Requirements

In the context of the LHA-1 Class EOC development phase, an SEA is the detailed procedure whereby selected systems are analyzed to evaluate the adequacy of existing maintenance strategies and to define anticipated maintenance requirements. Maintenance requirements resulting from the SEA are defined at an equipment level and incorporated in the CMP, which becomes a plan for executing the EOC maintenance strategy. In essence, the SEA determines what should be done, when it should be done, and who should do it.

EOC programs that have preceded LHA-1 Class EOC development have been based almost exclusively on the analysis of ship class historical data. Existing maintenance strategies have been derived, failure trends have been established, and future requirements have been projected to optimize expenditures of maintenance resources. For the LHA-1 Class, while the objective remains the same, the limited amount of historical information necessitates a modified approach. As previously discussed, preliminary analysis of the existing class data indicates that a SEA based on the number and types of failures experienced to date would, for most equipments, provide inconclusive results.

Although detailed definition of an appropriate SEA methodology for developing the LHA-1 Class EOC Program exceeds the scope of this study, some factors have been identified as being relevant to the SEA. These factors, which should be considered both in the selection of SEA candidates and in the SEA methodology, are summarized as follows:

- Maintenance strategy. The LHA-1 Class shipbuilder included in the LHA-1 Class PFM a detailed definition of the maintenance strategy required to support most installed equipments. These documented maintenance strategies were based on an MEA, which was based on anticipated failures and the availability of anticipated maintenance resources. Any deviation from these defined maintenance strategies could be interpreted as a problem requiring a redefinition of the maintenance strategy. However, some deviation is to be expected. Any SEA performed to redefine an equipment's maintenance strategy must consider whether sufficient new data have been compiled to support a change.

- Maintenance capability. For the LHA-1 Class, maintenance capability, although related to maintenance strategy, should be treated separately. The reason for this is that an extensive IMA capability was incorporated in the LHA-1 ship's design. Analysis of the MDS data compiled to date shows that off-ship IMA support has been a major factor in the accomplishment of emerging maintenance requirements. Initial indications are that additional support will continue to be required throughout the life cycle of the ship class. What the SEA must consider, but what is not currently defined, is the extent to which a ship of the LHA-1 Class is capable of providing its own IMA support.

- Ship class equipment commonality. This study has established that approximately 43 percent of APLs applicable to the LHA-1 Class are also applicable to other EOC ship classes. This indicates that, for these equipments, there is probably an adequate historical data base from which EOC maintenance requirements may be derived. However, because of commonality, it is highly probable that many of these same equipments are inconsequential; for example, such items as hand lanterns and small boat equipage would logically have commonality, but would not be considered a significant maintenance burden. Another factor that must be considered before using data compiled by other EOC ship classes is whether the equipment application and utilization are the same as for the LHA-1 Class.

- CMP development. CMP tasks to be developed as an output of the SEA should document off-ship maintenance requirements for all maintenance-worthy systems and equipments regardless of whether or not they have a history of maintenance problems. Accordingly, the SEA should address all aspects of the installed system and equipment; i.e., anticipated failures as well as failures that have occurred should be considered.

- SEA candidates. Systems and equipments identified in Table 3-10 of this report as candidates for an SEA were selected on the basis of the rationale that they have accumulated the most significant historical corrective maintenance burden of all systems and equipments. This does not, however, imply that the historical maintenance burden alone is a sufficient data base from which CMP requirements may be developed. It is expected that, as the EOC Program development phase effort continues, additional SEA candidates will be identified.

- Historical data analysis. This analysis has identified systems and equipments as maintenance-critical by focusing on only a portion of the historical data base. While it is unlikely that as a result of a more detailed analysis of the data, additional maintenance-critical items will be identified or the difference in burden between one item and another would change significantly, the data base probably contains relevant maintenance data that were not used; i.e., relevant data may have been reported against various invalid APL numbers, but because of the small quantity of data the APLs were disregarded. The SEA should attempt to identify all

relevant data for each selected system or equipment and should critically evaluate all reported maintenance actions, including parts-only transactions, without regard to reported status or cause codes.

3.5 ALTERATION REQUIREMENTS

As discussed in Sections 2.5 and 3.4, alterations to maintenance-critical systems and equipments were reviewed to determine their potential impact on the reported maintenance burden and to determine whether current priorities and schedules for accomplishment should be modified. The quantity and nature of failures and malfunctions reported were considered as they related to the nature and scope of the alteration.

Of the alterations listed in Table 3-9 as having significant impact on maintenance-critical systems and equipments, ShipAlts 200D, 256K, and 214K are the only ones not currently programmed for accomplishment on LHA-2 before EOC is implemented. ShipAlt 214K (replacement of firemain butterfly valves) appears to have been accomplished as class item 1009 on LHA-1 and LHA-2, but this should be verified through a ship check.

Because there is considerable lead time prior to EOC implementation for ships other than LHA-2, and because ShipAlt schedules and priorities are periodically reviewed and modified, individual ship priorities and schedules for other ships of the class were not evaluated in depth. However, on the basis of information available to date, the current alteration package appears to be adequately defined. The quantity of historical data accumulated by the class and the types of failures reported cannot support a firm recommendation for accomplishing an alteration as an EOC prerequisite.

3.6 PRE-EOC OVERHAUL REQUIREMENTS

As discussed in Section 2.6, pre-EOC overhaul requirements were defined as requirements considered necessary to return a degraded system or equipment to an acceptable material condition before the class enters EOC. Each of the 20 top-ranked maintenance-critical systems and equipments was examined in depth through a detailed review of the MDS and CASREP data narratives. In each case, all narratives were considered without regard to documentation coding or the absence of man-hour documentation. Although a detailed trend analysis was not conducted, there appeared to be a random distribution of maintenance actions relative to time and the level of equipment or component identification. Thus, a pattern of deterioration was not evident from the data.

On the basis of historical maintenance data accumulated to date, it is anticipated that LHA-1 Class ships may be entered into an EOC Program

without undergoing a baseline overhaul. Corrections of material deficiencies discovered during routine pre-overhaul tests and inspections (POT&Is) conducted prior to regularly scheduled overhauls should result in an adequate material condition for implementation of EOC upon completion of the routine overhaul.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

This report has presented data analyzed and reviewed in the performance of the initial effort in the development phase of an Amphibious Engineered Operating Cycle (PEOC) Program for LHA-1 Class ships. Conclusions are based on data sources identified in the study. Major conclusions derived are as follows:

- Current PEOC Program objectives require completion of the LHA-1 Class EOC Program development phase in fiscal year 1983. This coincides with completion of a regular overhaul (ROH) on the USS SAIPAN (LHA-2), which will therefore be the first ship subjected to full implementation of the EOC Program. The USS TARAWA (LHA-1) is scheduled to complete ROH in fiscal year 1982, prior to completion of the PEOC development phase effort; it could be subjected to a phased implementation of the EOC Program as program requirements are defined.
- The following current development phase tasks, not included in this report, will have an impact on future development phase requirements:
  - •• Develop the LHA-1 Class EOC Program Management Plan (PMP). The PMP will provide objectives and constraints to guide development and implementation of the program.
  - •• Develop the methodology for a systems engineering analysis (SEA). The SEA methodology will define a structured approach for performing the systems engineering analysis of the development phase.
  - •• Identify documented off-ship maintenance requirements. Systems and equipments of the LHA-1 Class that appear to have adequately defined IMA and depot level maintenance tasks will be identified for incorporation in the class maintenance plan (CMP). An SEA may be recommended for systems and equipments that appear to have inadequately defined off-ship maintenance requirements.
  - •• Develop a common configuration class list (CCCL). The CCCL, which will provide a definitive definition of the LHA-1 Class configuration, will also divide systems and equipments into

ship work authorization boundary (SWAB) groups. The CCCL will be used to limit the number of equipments on which SEAs will be performed and will serve as the basis for development of the CMP.

- The next effort in the development phase is the performance of SEAs and the development of the CMP. As these efforts are begun, additional development phase requirements may emerge that will affect the overall development phase effort.
- Analysis of collected historical data indicates that no single system or equipment has compiled a maintenance burden sufficient to merit further in-depth SEAs. The systems and equipments identified in this report as maintenance-critical have been the most significant contributors to the corrective maintenance burden of ships of the class; thus, they represent potential maintenance problems.
- Six major ship systems offer the greatest potential benefit from in-depth SEAs. These systems, as defined in the shipbuilder's plan for maintenance (PFM), are suitable candidates for an SEA because (1) the historical maintenance burden for some equipments in each PFM exceeds the total maintenance prediction for all included equipments; (2) ship visits have confirmed the apparent existence of maintenance-related problems within each system; and (3) an independent analysis by PERA (ASC) of maintenance-critical systems of other ship classes supports their selection. Major ship systems identified as candidates for SEAs are the following:
  - Damage control monitoring and interior communications systems
  - Saltwater and ballast systems
  - Hull and hull fittings, including preservation and painting
  - Aircraft handling and assault systems
  - Ventilation systems
  - Radio communications systems

These major ship systems consist of numerous complex subsystems and equipments. Individual systems and equipments identified in this report as maintenance-critical provide an initial baseline list for beginning the SEA. Use of this list will direct analytical efforts to areas where an engineering maintenance strategy can be developed from historically derived maintenance problems.

- The SEA will provide only a partial compilation of maintenance requirements for the EOC Program. Other sources of information, such as the shipbuilder's design data, other EOC Class CMPs, and historical data from other ship classes for common equipments, must be researched to document the total IMA and depot level maintenance strategy for systems and equipments not subject to an SEA.

- The historical maintenance data accumulated to date are insufficient for the definitive development of CMP projections. The CMP development process must use design data supplemented by historical data compiled by other ship classes. This study has shown that there are sufficient data to establish the feasibility of such an approach. Specific criteria for the development of the CMP have not yet been defined but may be evolved as the development phase progresses.

- Because LHA-1 Class ships have an on-board maintenance capability far exceeding that of previous EOC ship classes, a definitive study should be performed to determine the extent to which the LHA-1 Class is capable of providing its own maintenance support. Such a study would support the CMP development process by determining level-of-repair assignments for each installed system and equipment and would identify systems and equipments to be included in the CMP.

- Historical maintenance data accumulated to date have been adequate for completing the current development phase tasks. However, because of the limited quantity of historical data available for LHA-1 Class ships, additional data are being obtained, and more will be required as the development phase continues. Historical data include both service life data (MDS and CASREP) and design data. Because of the volume of data being compiled, particularly design data, a central technical library should be established. Use of the design data will require further definition as data become available.

- Current alteration schedules and priorities are adequately defined in relation to EOC Program objectives. Additional alteration information should continue to be evaluated as it becomes available to further assess its impact on configuration and identified maintenance and technical problems.

- There are many technical problems and design deficiencies applicable to LHA-1 Class ships for which an appropriate corrective action has not been scheduled. Analysis of the available historical data indicates that these problems have not yet significantly contributed to the reported maintenance burden. However, because they represent potential problems related to EOC Program objectives, a concerted effort should be undertaken to ensure that each is resolved as quickly as possible.

- Ships of the LHA-1 Class may be entered into the EOC Program without undergoing a baseline overhaul. On the basis of collected historical maintenance data, it is concluded that a deteriorated state of material condition does not exist. Corrections of material deficiencies discovered during routine pre-overhaul tests and inspections (POT&Is) conducted prior to regularly scheduled overhauls should result in a material condition adequate for implementation of EOC upon completion of an ROH.

- Results of analyses are not conclusive enough to permit defining an ideal operating cycle for LHA-1 Class ships. The scheduling

of maintenance availabilities and overhauls, as a functions of maintenance requirements, must be determined upon completion of CMP development. Alternatively, if a predetermined number of deployments between overhauls is specified as an amphibious EOC Program objective, maintenance requirements may be engineered to meet that objective. An initial determination of the ideal operating cycle will be a product of the LHA-1 Class EOC PMP. If CMP requirements are inconsistent with the initial plan, a revised operating cycle may be developed.

- Future tasks for the EOC Program development phase not evaluated in this report include development of procedures for monitoring and assessing material condition, development of effectiveness procedures for the EOC Program, and development of a management information system (MIS). These elements of the EOC Program development phase will be addressed in the EOC PMP, which is currently being developed.

4.2 RECOMMENDATIONS

On the basis of the conclusions of this study, the following recommendations are made:

- Implement the EOC Program on each ship of the LHA-1 Class as the ship completes its first regular overhaul.
- Use the results of this report, together with the results of other development phase tasks, to determine future requirements of the development phase. Other development phase tasks pending completion are the following:
  - •• Develop the EOC Program Management Plan
  - •• Develop the methodology for a Systems Engineering Analysis
  - •• Identify documented off-ship maintenance tasks
  - •• Develop the common configuration class list
- Use the list of maintenance-critical systems and equipments presented in this report as an indicator of potential maintenance problems but not as a positive indicator of maintenance criticality. The list should be used to ensure that the systems and equipments that have historically been the greatest maintenance burden are considered in the development of maintenance requirements for the EOC Program.
- Begin the SEA process. SEA candidates identified in this report should be selected for initial application of the SEA methodology, which is currently being developed.
- Accomplish SEAs at a system level sufficient to encompass all subsystems and equipments, including but not limited to the systems and equipments identified as maintenance-critical.
- Begin to develop the CMP. CMP development should be consistent with objectives and constraints to be promulgated in the LHA-1 Class EOC PMP. Detailed definition of CMP format, development

criteria, and use should be included in the CMP document. SEAs and any additional engineering studies should be completed concurrently with and in support of CMP development.

- Perform engineering studies to develop CMP requirements in addition to those included in the SEA. These studies should include an in-depth evaluation of the shipbuilder's design data and a definitive study of LHA-1 Class on-board maintenance capabilities. Other engineering study requirements may be identified as the EOC Program development phase effort continues.
- Continue the data collection effort. Data that have been identified in this report as relevant to the development phase effort but have not yet been obtained should be collected as soon as possible so that completion of the development phase will not be delayed. A central technical library should be established to consolidate data resources. The following major data elements, which are not yet available, should be obtained:
  - •• A current Type Commander's COSAL data tape
  - •• Selected shipbuilders' contract data items
  - •• Current MDS and CASREP data tapes, with periodic updates as the development phase effort continues
- Continue to evaluate alteration schedules and priorities as ROH is planned for each ship of the class. Obtain and evaluate currently unavailable ShipAlt records as they are developed and assess their impact on configuration. Evaluation of relevant alterations should be an integral part of CMP development and the SEA process.
- Ensure that all identified corrective actions for known technical problems and design deficiencies are implemented prior to or at the same time as each ship's first ROH.
- Define an ideal EOC Program operating cycle within the EOC PMP as an objective for developing the CMP. Once the CMP is developed, however, the operating cycle should be reevaluated in the light of identified maintenance requirements.
- Defer decisions related to future EOC Program development phase efforts not addressed in this report until current development phase tasks are completed. Major elements yet to be considered are the following:
  - •• EOC Program procedures for monitoring and assessing material condition
  - •• EOC Program effectiveness procedures
  - •• EOC Program management information system (MIS) requirements

APPENDIX A

DATA SOURCE DESCRIPTIONS

This appendix describes the various data sources identified and used in this study, as well as other data elements identified for use during the development phase of the LHA-1 Class engineered operating cycle (EOC). Current and potential uses are discussed.

1. CONFIGURATION DATA

LHA-1 Class configuration data used in this study were obtained from a 1979 magnetic tape edition of the Atlantic Fleet and Pacific Fleet Type Commander's Consolidated Allowance List (TYCOM COSAL). This COSAL data tape contained 2,194 allowance parts list (APL) numbers applicable to the first two ships of the LHA-1 Class (LHA-1 and LHA-2), as well as APLs applicable to other ships of the fleet. This data source was used to validate historical maintenance data, identify equipment application by system, and establish LHA-1 Class equipment commonality with other EOC ship classes.

A magnetic tape of weapons systems file (WSF) number 17 was obtained, but was not used in the performance of this study. This tape contained WSF level A configuration data, compiled through January 1980, applicable to each ship of the LHA-1 Class. Because the data format was not readily compatible with available computer programs, and because PERA (ASC) is currently engaged in an effort to develop a definitive ship's system configuration index (SSCI) for the LHA-1 Class, the WSF data tape was turned over to PERA (ASC) for their use. The current effort of PERA (ASC) is expected to produce a common configuration class list. This list is critical to the ultimate development of the class maintenance plan (CMP); it will be used as a baseline for future EOC development efforts.

Because the currently available TYCOM COSAL data tape reflects only those numbers applicable to LHA-1 and LHA-2 ships, an up-dated edition should be obtained for use during further EOC development efforts. Liaison with the Navy Ships Parts Control Center (SPCC) has been established, and a revised COSAL data tape will be used when available.

2. MAINTENANCE HISTORY DATA

LHA-1 Class historical maintenance data compiled via the Navy 3-M maintenance data system (MDS) was acquired on computer tape from the Navy Maintenance Support Office (NAMSO). The data tape contains data compiled within the NAMSO data base through January 1980 by the first two ships of the class (LHA-1 and LHA-2). MDS data for other ships of the class were not available. There were 62,877 records of MDS transactions, reflecting all maintenance actions reported. The most recent maintenance action was in October 1979. The interim period (October 1979 through January 1980) is attributed to the time lag between ship's force preparation of a document and incorporation of the document in the NAMSO data base.

MDS data were used in this study to identify maintenance-critical systems and equipments and to evaluate as far as possible the current state of material condition. Because the available MDS data are limited to only two ships of the class, and because these ships are relatively new, periodic updates of the MDS data should be obtained and used throughout the EOC development phase. However, these data are and will continue to be of limited value as a direct source for identification and projection of long-range EOC maintenance requirements because of the lack of accumulated service life of the ships involved.

3. CASUALTY REPORT (CASREP) DATA

CASREP data for LHA-1 Class ships were acquired from the Navy SPCC in hard-copy form. The data consisted of all CASREPs prepared by LHA-1 Class ships from LHA-1 commissioning through December 1979. There were 891 CASREPs prepared by LHA-1 and LHA-2 ships. CASREPs prepared by other ships of the class were of insignificant quantity and were disregarded for purposes of this study.

CASREP data were used in this study as indicators rather than quantifiers of maintenance criticality. The number of CASREPs reported against each maintenance-critical system or equipment was tabulated and evaluated to ascertain if a correlation existed between those systems and equipments and items exhibiting casualties that resulted in a loss of mission capability.

Because of difficulties in obtaining appropriate CASREP data from the SPCC and the inflexibility of using hard-copy products, future CASREP data required during the EOC development phase should be acquired in magnetic-tape form. Periodic updates should be obtained and used throughout EOC development.

4. SHIP MODERNIZATION DATA

Alteration information applicable to LHA-1 Class ships was obtained by computer terminal from the Navy Ship Alteration Management Information System (SAMIS) data base. This information was then supplemented with

available ShipAlt records (NAVSEA 4720/4 documents), which were provided by PERA (ASC) and NAVSEA 941. The PERA (ASC) Ship Alteration Information Manual (SAIM) was also obtained and used as a supplementary data source. All of these data elements were used to evaluate the impact of each alteration and to refine the requirements for systems engineering analysis. Individual alterations applicable to the USS SAIPAN (LHA-2), the first ship of the class scheduled for EOC implementation, were evaluated to identify any alterations not currently programmed that should be accomplished prior to EOC implementation.

Additional class alteration information, including ShipAlt records not yet developed, should be obtained and evaluated as it becomes available. All alterations must be further analyzed during future EOC development efforts to establish their impact on configuration and associated maintenance requirements.

5. USS SAIPAN (LHA-2) TRANSFER DOCUMENT

The USS SAIPAN (LHA-2) transfer document, dated 22 May 1979, provided for the transfer of management responsibility from NAVSEA PMS-377 to NAVSEA 941. It included information relevant to known technical problems, class items, and Part I inspection and survey (INSURV) items. NAVSEA PMS-377 retained technical responsibility for applicable technical issues and included the status of each in the transfer document. This document was reviewed within the context of this study for identification of known technical problems and proposed corrective actions that would have a significant impact on maintenance-critical systems and equipments.

6. LHA-1 CLASS ITEM STATUS MATRIX

The LHA-1 class item status matrix report, dated 4 January 1980, was provided by PERA (ASC) and used to identify all known class items, together with the current status of each. Class items, which are generated from the contractor's acceptance trial and final contract trial deficiencies, were reviewed to determine if the correction of any item could be expected to have a significant impact on maintenance-critical systems and equipments.

7. LHA-1 CLASS RETROFIT STATUS REPORT

The LHA-1 class retrofit status report, dated June 1979, was provided by the USS SAIPAN (LHA-2) but was not used in this study. The retrofit status report, in conjunction with the LHA-1 class item status matrix report, may be used during future EOC development phase efforts as a composite reference source for the identification of known technical problems and design deficiencies applicable to each ship of the class. Future revisions of these two documents should also be used to identify corrective actions as they are completed. Scheduling and tracking of problems and deficiencies, however, are not projected to be results of EOC development. Rather, they should serve to ensure that projected maintenance requirements

are not predicated on design deficiencies that have been identified for correction.

8. SHIP SYSTEM TECHNICAL DATA

Detailed technical data compiled to date include a complete set of ship information books (SIBs) for the LHA-1 Class and miscellaneous technical manuals for various major ship systems. A Special Ship's Drawing Index for LHA-2 and Publication Applicability Lists (PALs) for LHA-1 and LHA-4 were also obtained. Although not used in this study, these documents, together with additional documents yet to be identified, will be required during engineering analysis and determination of material condition. Detailed requirements for additional technical data will be identified concurrently with identification and clarification of analytical requirements. It is expected that, at a minimum, selected ships' drawings and equipment technical manuals will be required. If so, these data items may be requisitioned on a case-by-case basis from the design yard or via the Navy stock system.

9. CURRENT MAINTENANCE STRATEGY DATA

Navy 3-M planned maintenance system (PMS) data for the LHA-1 Class were obtained from Naval Ships Sea Center Engineering Pacific (NAVSEA-CENPAC). These data, which include a complete set of current maintenance index pages (MIPs) and maintenance requirement cards (MRCs), may be used in performing engineering analyses and developing the CMP.

10. SHIP MANPOWER DOCUMENT

The LHA-1 Class Ship Manpower Document (OPNAVINST 5320.332, dated March 1978) was obtained from NAVSEA PMS-377. It may be used during future EOC development efforts for assessing manpower adequacy in relation to anticipated maintenance requirements. The Ship Manpower Document (SMD) serves as the basis for the class manpower authorization, which is reflected and updated via the Navy Enlisted Distribution and Verification Report (EDVR) for each ship of the class. The EDVR should be a better data source than the SMD for assessing manpower adequacy; however, a source of procurement has not yet been identified.

11. WEAPONS QUALITY ENGINEERING CENTER (WQEC) REPORTS

Various MDS and CASREP products developed by the WQEC from LHA-1 Class data were evaluated. It was determined that selected WQEC products may be useful for monitoring EOC Program effectiveness, but that they offer little potential for use during the development of the EOC Program.

12. SHIPS SUPPORT IMPROVEMENT PROJECT (SSIP) REPORTS

Concurrently with the development of the FFG-7 Class LO-MIX logistics support analysis file (LSAF), NAMSO compiled selected LHA-1 Class maintenance engineering analysis (MEA) data elements in LSA format. Selected reports from this LHA-1 Class LSA file were evaluated as a potential data source. It was determined that a lack of compatibility between MEA and LSA data elements precluded comprehensive incorporation of the MEA data into the LSAF. Therefore, future EOC development efforts should use the MEA itself as a primary data source.

13. MISSION AREA TREND CHARTS

Readiness Information Service (RIS) data for LHA-1 Class ships were evaluated as a potential source of information for correlating the results of historical maintenance data analyses. However, the broad range within which readiness trends are defined and the small quantity of readiness data collected on the class to date prevented such a correlation.

14. SHIP CLASS DESIGN DATA

LHA-1 Class design data, as described in the shipbuilder's contract data requirements list (CDRL), were reviewed to identify data elements that would be useful to the overall EOC development phase effort. Individual CDRL items were then identified to PERA (ASC) as required items. Future EOC development phase efforts will require a thorough evaluation of each design data element to determine its specific relevance to life-cycle maintenance management of the ship class.

Design data items that have been collected or are being collected are described in the following subsections.

14.1 Plans for Maintenance (PFMs)

The shipbuilder produced a set of 50 PFM documents applicable to each of the five ships of the LHA-1 Class. These documents are essentially the same from one ship to another, except for configuration differences. They identify and describe the anticipated logistics resources required to support the various systems and equipments of each ship. The PFMs address such topics as:

- Maintenance concept
- Reliability and maintainability
- Failure modes and effects
- Preventive maintenance requirements and tasks
- Corrective maintenance requirements and tasks
- Personnel planning factors

A partial set of PFM documents has been compiled for each ship of the class, so that a set of documents encompassing the 50 PFM systems is available. Individual ship documents not currently available have been identified to PERA (ASC); they are being acquired.

For this study, the PFM documents were used to compare anticipated and actual maintenance burdens for the purpose of evaluating maintenance criticality. Future EOC development efforts will provide an evaluation of each system's or equipment's projected off-ship maintenance requirements for incorporation in the CMP.

14.2 Maintenance Engineering Analyses (MEAs)

MEAs, the primary documents from which the PFMs were developed, were prepared at an APL level. They provide information, not available in the PFM, related to the definition of anticipated maintenance requirements. A partial set of MEA documents was obtained from SupShips Pascagoula and inventoried against available PFM documents to determine the availability of MEAs containing off-ship maintenance projections. The focus of effort was on the LHA-2. Unavailable MEAs applicable to the LHA-2 that contained off-ship maintenance requirements were identified to PERA (ASC); they are being acquired.

MEA documentation was not used in this study, but it will be used, with the PFM documentation, during future EOC Program efforts for development of the CMP.

14.3 Test Reports

SupShips Pascagoula provided a partial set of the LHA-1 Class shipbuilder's test procedures and completed test reports for the LHA-3. The shipbuilder used these test procedures and test report documents to demonstrate compliance with contractual requirements for the function and performance of each ship's systems and equipments. As such, the reports provide documentation of baseline operating parameters and procedures that may be used in the development of requirements for EOC Program material condition assessments (MCAs). Unavailable test reports are being acquired.

14.4 Other Design Data

On 28 and 29 May 1980, meetings were held at the shipyard of the LHA-1 Class shipbuilder, and were attended by representatives of the shipyard and various Navy activities concerned with the disposition of the shipbuilder's central data bank. The meetings resulted in the determination that some data items, such as blueprints, would be turned over to Puget Sound Naval Shipyard (the design yard for the LHA-1 Class), and that other data items would be turned over to PERA (ASC). Items for PERA (ASC) that could be useful in future EOC development efforts are the following:

- Life-cycle-cost updates and status reports
- Machinery history reports

- Peculiar support equipment ashore listings
- Common support equipment ashore listings
- Functional task analysis reports
- Reliability and maintainability assessment reports
- Reliability, availability, maintainability, and simulation (RAMSIM) computer software
- Failure modes and effects analyses (FMEAs)
- Reliability and maintainability data collection reports
- Key configuration element (KCE) envelopes
- Gross hazard study
- Safety analysis (system), and subsystem and operating safety analysis
- Equipment component list for vibration test exceptions
- Reliability, availability, and maintainability data for mathematical modeling
- Trouble and failure reports
- Critical items list and report
- Component reliability and standards reports
- Life-cycle-cost trade-off studies
- Life-cycle-cost update report
- PFM and MEA documents

APPENDIX B

MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS

Table B-1 is a list of LHA-1 Class maintenance-critical systems and equipments. The systems are grouped and sequentially arranged by ship work authorization boundary (SWAB) number; individual equipments are identified by allowance parts list (APL) number. These systems and equipments were identified from an analysis of historical maintenance data that was compiled by forces afloat for LHA-1 Class ships covering the period from LHA-1 commissioning through October 1979. All data compiled by NAMSO through December 1979 were considered. Descriptions of data elements in Table B-1 are as follows:

- SWAB number: The ship work authorization boundary number for the identified system as defined in NAVSEA 0900-LP-098-6010.
- Nomenclature: The name of the identified system or equipment.
- APL number (validated): The allowance parts list number for the identified equipment. APL numbers were reported via the MDS by forces afloat and validated through comparison with the Type Commander's COSAL. If the APL number was found to be incorrect, the corrected APL number is tabulated in parentheses immediately following the reported APL number.
- EIC number (validated): The equipment identification code number for the identified system or equipment. EIC numbers are used to identify systems and equipments only if the APL number was not reported in the MDS. EIC numbers were validated through a review of MDS narratives; if they were found to be incorrect, the corrected EIC number is tabulated in parentheses immediately following the reported EIC number.
- Historical maintenance summary: A profile of historical critical maintenance burden indicators for each identified system and equipment.
- CMA_C: The number of critical corrective maintenance actions reported for each identified system and equipment. CMA_C was calculated as the total number of corrective maintenance actions reported for which the reported status code was 2 (nonoperational) or 3 (reduced capability) and for which an expenditure of labor was reported.

- Ship's force man-hours: The total number of ship's force man-hours reported for accomplishment of CMA_C on the identified system or equipment during the reporting period.
- IMA man-hours: The total number of intermediate maintenance activity CMA_C man-hours reported.
- Total man-hours: The total number of CMA_C man-hours (ship's force plus IMA) reported. All APLs and EICs with an accumulated total of 100 or more CMA_C man-hours are tabulated in this appendix.
- Number of CASREPs: The total number of casualty reports compiled via the consolidated casualty reporting system for the identified maintenance-critical system or equipment.

Table B-1. LHA-1 CLASS MAINTENANCE-CRITICAL SYSTEMS AND EQUIPMENTS

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
120-1	Structural Bulkheads, Decks							
	• Compartments		A905	27	270	0	270	1
150-1	Structural, Superstructure							
	• Superstructure Decks		A603	6	322	0	322	0
167-1	Watertight Doors, Hatches, Scuttles							
	• Hatches		AD05	20	104	0	104	0
	• Hull Structure, Doors		AD01	41	335	52	387	0
	• Doors, Hatches, Mn Hole, Scuttles		AD00	28	242	30	272	2
	• Access Door Port Shell Closeout	3122[illegible]3B		42	376	109	485	0
	• Access Door Sliding CL Elevator	3122[illegible]002 (312290002B)		6	344	0	344	2
	SWAB 167-1 Total			137	1,401	191	1,592	4
221-1	Propulsion Boilers							
	• Mn Stm Boiler	021450083B		94	1,286	620	1,906	12
	• Mn Stm Boiler	021450083 (021450083B)		4	48	204	252	16
	• Mn Stm Boiler		F101	25	116	16	132	5
	• Globe Vlv, 0.75 IPS 600 psi	882056639		1	2	116	118	0
	SWAB 221-1 Total			124	1,452	956	2,408	33
221-3	Boiler Blow System							
	• Angle Vlv, 1.5 IPS 600 psi	882003486B		6	79	550	629	0
231-1	Propulsion Stm Turbines							
	• Mn Stm Turbine	051800372B		2	125	0	125	2
243-1	Propulsion Shafting							
	• Shft Seal TBID 24.50	83100219B		9	77	80	157	6
244-1	Propulsion Shaft Bearings							
	• Brng Assy Line Shaft	371010236B		4	149	0	149	0
251-1	Forced Draft Blowers							
	• FDB	057800205B		18	140	0	140	0

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
252-1	Automatic Propulsion Control							
	• Data Logger Alarm/Bell	73326361 (467060002B)		5	264	0	264	0
	• Control Panel Mn Stm/Wtr Level	50114020B (501140020B)		1	226	0	226	0
	• Control Panel, Burner Management	501140021B		6	195	0	195	0
	• Control Panel, Ship Control Steering Console	501170003B		7	153	0	153	1
	• Cir Card Assy, Ship Control Steering Console	6101100013B		2	118	0	118	0
	• Pwr Arc Ignitor Proj Console, Blr	710060001B		5	326	89	415	1
	• Console, Ship Control, Pilot House	619980231B		51	521	10	531	0
	• Console, Ship Control, Engine Room	619980232 (619980232B)		48	392	117	509	5
	• Generator Control Console	619980233 (619980233B)		73	594	24	618	0
	• Generator Control Console	619980233B		33	1,091	0	1,091	0
	• Console, Eng Rm, Control	619980234 (619980234B)		98	239	75	314	2
	• Circuit Card Assy, Ship Control Console	619980234B		6	308	0	308	0
	• Mn Proj Aux Mach Controls, Central		FJ00	26	1,327	6	1,333	0
	• Proj Mach Controls, Sys Components		FJ01	22	1,124	0	1,124	1
	• Aux Mach Controls, Sys Components		FJ03	8	239	0	239	0
	SWAB 252-1 Total			391	7,117	321	7,438	10
253-1	Main Steam Piping							
	Vlv Operator, Mtr Driven	619010127B		2	170	180	350	1
	Vlv Operator	619560051B		1	0	115	115	2
	SWAB 253-1 Total			3	170	295	465	3
254-1	Main Condenser and Air Ejector							
	Mn Condenser	040280032B		7	180	148	328	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
254-2	Aux Condenser and Air Ejector							
	• Vac Pmp, Rty Pwr, 4.3 cfm	016720053B		7	323	0	323	1
	• Vac Pmp, Rty Pwr, 4.3 cfm	09471808010 (016720053B)		1	176	0	176	0
	• Blower, Positive Displacement	40115002B		1	132	0	132	6
	• Aux Condenser	040280033 (040280033B)		2	29	80	109	1
	SWAB 254-2 Total			11	660	80	740	8
255-2	Main Feed Pump							
	• MFP, 588 gpm, 7[illegible] psi	016021434B		23	349	0	349	3
	• Mtr-Aux LO Pump, 44[illegible] V, 7[illegible] HP	174660834B		3	273	0	273	0
	SWAB 255-2 Total			26	622	0	622	3
255-3	Main Feed Booster, Emerg, Transfer Pumps							
	• Emergency Feed Pump	016031734		18	228	369	597	3
	• Main Feed Booster Pump		P300	2	104	8	112	0
	SWAB 255-3 Total			20	332	377	709	3
255-5	Main Condensate Pump							
	• Mn Cond Pump, 4[illegible] gpm	016021162 (016021162B)		4	57	401	458	3
261-2	FO Service Pumps							
	• Mtr Drvn F Sf, [illegible] gpm	016160789 (016160789B)		1	690	0	690	4
	• Mtr Drvn F Sf, [illegible] gpm	016160789B		11	167	8	175	0
	• Hand Stripping Pump	016[illegible]238		2	102	0	102	0
	SWAB 261-2 Total			14	959	8	967	4
264-3	LO Purifiers							
	• Mtr, LO Purifier, 44[illegible] Vac	174752251		4	65	77	142	1
	• Purifier, Centrifugal	760200200		8	112	10	122	0
	SWAB 264-3 Total			12	177	87	264	1

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	ABL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA/G	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
311-1	S/S Steam Turbine Generator Set							
	• Generator, Stm Turbine	5726,227 (5726227B)		9	224	244	468	8
312-1	Emergency Diesel Generator Set							
	• Diesel Engine, 2,[illegible] HP	664.1[illegible]28B		49	902	258	1,160	3
	• Diesel Engine, 2,[illegible] HP	664.1[illegible]24 (664.1[illegible]24B)		12	235	61	296	1
	• Generator, 2,[illegible] KW, 4[illegible] V	1[illegible]13B		7	432	0	432	4
	• Hydraulic Pkg	7.11[illegible]74B		2	60	47	107	1
	SWAB 312-1 Total			70	1,629	366	1,995	9
314-1	4[illegible] Hz Motor Generator							
	• M[illegible] KW, [illegible] 4[illegible] Hz, 4[illegible] V, [illegible] HP	1[illegible]74B		14	376	130	506	1
32[illegible]-1	Power [illegible]							
	• [illegible]ctor, Pwr Switch		4[illegible]	8	580	0	580	0
	• [illegible]ssel's Power Distrib		46	2	288	0	288	0
	SWAB 32[illegible]-1 Total			10	868	0	868	0
[illegible]-1	Electrical Pwr Switch, Rear [illegible]							
	• A[illegible] Relay	1[illegible]		2	245	0	245	0
33[illegible]-1	Lighting Distribution & Fixtures							
	• Hand Lantern, [illegible] Vs	24[illegible]13B		41	266	61	327	0
	• Light Dist Fuse Box, TY 1B-S	[illegible]247		1	304	0	304	0
	• Flight Lighting Fixture, TY M[illegible]-1[illegible]	24[illegible]746		18	211	0	211	0
	• Light Fixtures		4[illegible]	21	139	2	141	0
	• Light Fixtures		4635	7	68	38	106	0
	SWAB 330-1 Total			88	988	101	1,089	0
342-1	Diesel Generator Support Systems							
	• FO Pump, Rty Pwr, 11 gpm, 21 psi	[illegible]16163659		1	114	0	114	0

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
421-1	Non-Elec/Electronic Navigation Systems							
	• Navigation Equipment, Viewing	2-240034027 (C240034024)		5	8	94	102	0
	• Binocular, Handheld	2-240034032 (C240034032)		28	88	194	282	0
	• Binocular, Ship's	2-240034024 (C240034024)		6	79	189	268	0
	• Clock, Gen Purp	2-240034131 (C240054131)		5	11	124	135	0
	SWAB 421-1 Total			44	186	601	787	0
423-1	Electronic Navigation							
	• URN 20A/20B	58502705		38	3,893	0	3,893	10
	• AN/URD-4D, Direction Finder Set	58462620		11	172	0	172	4
	• AN/UQN-4, Sonar Sounding Set	58413900		16	143	0	143	2
	SWAB 423-1 Total			65	4,208	0	4,208	16
426-1	Gyro Compass System							
	• Gyro, Mk 19 Mod 3D	252360046		11	259	115	374	4
	• Amp, Synch Snl, Gyro	253760029		2	14	101	115	0
	SWAB 426-1 Total			13	273	216	489	4
43X-X	IC Systems							
	• IC System		M000	15	106	20	126	1
431-1	IC Switchboards							
	• J-3062/STC-1 P/O LHA IVCS	72325000B (72325000FB)		2	118	0	118	0
	• IC Switching Center	72325000		204	1,448	18	1,466	1
	SWAB 431-1 Total			206	1,566	18	1,584	1

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
432-1	Telephone Systems							
	• Hand Set, IVCS	67021678		36	1,038	0	1,038	0
	• Head Set, H-200/U	67190000		20	381	3	384	0
	• Head Set, H-320/U	67021680		18	247	0	247	0
	• LS-444/WIH, Loudspeaker	72754400		11	275	0	275	0
	• S/P Phone Terminal Box	999970045		3	155	0	155	0
	• S/P Phone Terminal Box	999970915		2	115	0	115	0
	• IC Pwr Supply Assy	79607115		7	113	0	113	0
	• Dial Telephone Terminal	88633465		163	2,129	34	2,163	0
	• S/P Phones "J" Circuit		M403	25	262	2	264	0
	• Telephone System		M400	13	258	0	258	0
	• IVCS Telephone System		M311 (M401)	5	2,024	2	2,026	0
	SWAB 432-1 Total			303	6,997	41	7,038	0
433-1	Announcing Systems							
	• 21 MC Speakers	72754418 (Not Listed)		3	313	0	313	0
	• AM-2316 C/SIA, Amplifier	52231615		8	134	0	134	0
	• AN/SIA-118A, Amp Oscill Grp	56905205		13	103	0	103	0
	• AM-4154/SIA, Announcing System	52231615FA		3	102	0	102	0
	SWAB 433-1 Total			27	652	0	652	0
434-1	Entertainment, Training, TV							
	• Camera Control	30515714		16	243	0	243	0
	• Ent, Trng, Misc Apl	31397312		7	108	0	108	0
	• Briefing Audio Set	31397314		1	285	0	285	0
	• Video Console Grp, CCTV	31397307		19	346	0	346	0
	• Camera, Studio, Ent Sys	30515711		11	163	0	163	0
	• Photo Equip, Misc	2-850004053 (C850004053)		22	110	1	111	0
	• UHF/VHF Tuner	30890413		10	110	0	110	0
	• Camera, Film Chain	30515712		3	105	0	105	0
	• Camera, Type I	30515709		26	894	0	894	0
	SWAB 434-1 Total			115	2,364	1	2,365	0

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
436-1	Alarm, Safety, Warning Systems							
	• Alarms, Various Components	232540009		27	2,207	0	2,207	0
	• Detector, Temp Switch	214040003B		8	1,027	0	1,027	0
	• Swbd, Alarm	221570005B		7	102	1	103	1
	• Circuit Card Assy, Smoke Detector	611440003B		2	118	0	118	0
	• Swbd Alarm, Smoke Detector	221570002B		3	112	0	112	0
	• Temp, Fire Alarm System		V701	2	104	0	104	0
	SWAB 436-1 Total			49	3,670	1	3,671	1
437-1	Indicating, Order, Metering Systems							
	• Cell, Conductivity, Salinity	381040085B		5	272	0	272	0
	• Xmitter, Liquid Level	384890635 (384890665B)		3	221	0 0	221	0
	• Amp, Synchro Sig	253830038		2	127	0	127	0
	• Indic Xmitter, Mk 6 Mod 0	870010151		10	115	0	115	0
	• Circuit BC, Combustion Control		M604	11	277	0	277	0
	• Circuit 2SB, Salinity Indicator		M61X	7	188	0	188	0
	• Damage Control Console	616240003 (616240003B)		75	567	13	580	3
	• Damage Control Console	616240003B		14	257	0	257	0
	SWAB 437-1 Total			127	2,024	13	2,037	3
437-2	Tank Level Indicating System							
	• FO Tank Level Indicating		TD08	10	402	0	402	0
440-4	Message Process Distrbtn Syst							
	• TT-640(V)UY, Line Printer	92821812		13	484	0	484	1
	• TT-642(V)3/UG, Teleprinter	92818118		21	406	0	406	6
	• RD-281(V)UVK, Mag Rcdr	81636503		16	164	0	164	1
	• AN/UYA-5, Msg Term Controller	58735112		30	1,223	0	1,223	3
	SWAB 440-4 Total			80	2,277	0	2,277	11
441-1	Communications Antenna Systems							
	• AS-2873/SRC-OE-156SRC	78185610FA		12	172	0	172	6
	• Antenna Control OK-278/SS	78300027		5	156	10	166	0
	• AS-2813/SRC, Radio Antenna	59309951		11	159	0	159	4
	SWAB 441-1 Total			28	487	10	497	10

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
441-2	Antenna Multicouplers, Tuners							
	• AN/URA-38A, Antenna Coupler Group	5843380[illegible]		16	325	0	325	4
	• Antenna Coupler Group	7804[illegible]208CL		10	145	0	145	3
	• AN/URA-65V, Coupler Group	571-2360CL		24	111	0	111	0
	SWAB 441-2 Total			50	581	0	581	7
441-3	Communications Transmitters							
	• [illegible]-46 (V)1, Transmitter Gr;	2874282[illegible]CL		24	140	0	140	3
	• AN/WRT-1A, CBXF Radio	5[illegible]1-1[illegible]4		11	127	0	127	2
	SWAB 441-3 Total			35	267	0	267	5
441-4	Communications Receivers							
	• R-[illegible]A/URR, Radio Receiver	[illegible]1[illegible]1		24	300	0	300	0
441-5	Communications Transceivers							
	• AN/PRC-[illegible], Type I	[illegible]661[illegible]6		62	289	2	291	1
	• AN/PRC-[illegible], Type II	5661[illegible]03		28	103	0	103	0
	• AN/URC-81	5844674[illegible] (5844674[illegible]CL)		37	271	6	277	9
	• AN/URC-[illegible]	5844674[illegible]CL		[illegible]	305	0	305	22
	• AN/URC-[illegible]	5844[illegible]2[illegible]		[illegible]	249	0	249	0
	• AN/[illegible]-[illegible]	5846461[illegible]CL		37	172	0	172	5
	• AN/[illegible]-[illegible]	5846461[illegible]CL		23	111	0	111	2
	• AN/[illegible]-[illegible], Radio Set Gr;	5846461[illegible]CL		45	172	6	178	5
	SWAB 441-5 Total			347	1,672	14	1,686	44
441-6	Remote Communications Devices							
	• SA-[illegible]48/UX-[illegible], Switching Unit	5[illegible]1-[illegible]26		31	193	14	207	7
	• AB-[illegible]/[illegible], [illegible] Distr Panel	5[illegible]21-[illegible]13		7	133	0	133	0
	• AN/URA-[illegible], [illegible]-Converter	5[illegible]316-1		7	117	0	117	0
	SWAB 441-6 Total			45	443	14	457	7
446-1	Teletype and Facsimile							
	• AN/[illegible]-61A	5[illegible]1-46		9	121	0	121	1

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
446-1	Security Equipment							
	• TSEC/KW-7, Teletype		9F10	1	230	0	230	0
	• TSEC/KW-7, Teletype	92601500		63	415	0	415	1
	• TSEC/KWR-37A	92601290SA		15	115	0	115	1
	SWAB 446-1 Total			79	760	0	760	2
451-1	Surface Search Radar							
	• AN/SPS-10F	57036630		29	314	0	314	2
452-1	Air Search Radar							
	• AN/SPS-40B	57039655		28	393	0	393	8
453-1	Height Finding Radar							
	• AN/SPS-52B		P31Y	3	819	0	819	0
	• AN/SPS-52B, Computer Grp	78305002		43	12,635	0	12,635	2
	• T-1222/SPS52B, Transmitter	88486009		39	445	0	445	4
	• R-1782/SPS52B, Receiver	81151325		29	386	0	386	1
	• Power Supply/SPS-52B	79607110		7	175	0	175	1
	SWAB 453-1 Total			121	14,460	0	14,460	8
455-1	Identification System (IFF)							
	• AN/UPX-23, Interrogator Set	58393723		22	104	0	104	4
471-1	Active ECM							
	• AM-4530A/ULQ6A, Radio Freq Amp	52503132		8	405	0	405	3
472-1	Passive ECM							
	• AN/WLR-1C, Rcvr w/Tuner	58981717		23	238	3	241	1
	• AN/WLR-1C PC1	58981720 (58981730)		3	126	2	128	1
	SWAB 472-1 Total			26	364	6	369	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
481-1	Gunfire Control Systems							
	• AN/SPQ-9, Radar	49402746		42	179	0	179	3
	• AN/SPG-60, Radar	49402749		29	377	0	377	6
	• Computer, Mk 152 Mod 2	49402773		22	350	10	360	1
	• Radar Antenna, Mk 34 Mod 2	49402748		8	168	0	168	1
	• Gun Control Console, Mk 68 Mod 4	49402225		48	148	0	148	3
	• Signal Translator, Mk 1 Mod 3	49402229		10	677	0	677	4
	SWAB 481-1 Total			159	1,899	10	1,909	18
482-1	Missile Fire Control Systems							
	• Mk 115 Mod 0 MFCS	49401909		88	197	0	197	7
491-1	Elec, Test, Checkout, Monitor Equip							
	• AN/USM-491, Test Set Circd Assy	58606901		22	342	51	393	1
	• AN/USM-281C, Oscilloscope	58617025		54	143	108	251	0
	• Signal Generator, Test	61856903		3	3	158	161	0
	• Signal Generator, Test	30378209		12	67	41	108	0
	• Test Equipment		1804	4	447	2	449	0
	SWAB 491-1 Total			95	1,002	360	1,362	1
492-3	Pilot Landing Aid, TV System							
	• Flight Deck Surveil System		M104	5	122	0	122	0
493-1	Management Data Processing Sys							
	• Computer, Digital		QK00	63	243	0	243	0
	• Computer, Terminal Transcbr		QQ36 (QH36)	13	268	0	268	0
	SWAB 493-1 Total			76	511	0	511	0

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)		Historical Maintenance Summary			
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
495-3	TACSUPCEN, Spcl Purpose Intel System							
	• AN/UYK-7(V), Computer Set	58735398CL		27	277	0	277	1
	• PPI Display Console, OA-7979(V)-10/UYA-4(V)	78049077		122	1,197	0	1,197	1
	• RO-367(XN-1)/UYK, Card Punch	83317866		24	735	8	743	5
	• RD-294(V)/UYK, Rcvr, Rpdr	81694901		80	541	0	541	8
	• RO-280/UYK, Line Printer	83315451		21	414	0	414	2
	• CV-2036(V)/USQ-20(V), Digital Conv	62762811		10	220	0	220	1
	• C-8408(P) AN/UYK-7(V), Controller	61399848		2	159	0	159	0
	• RP-161/UYK, Punch Card Rdr	83416361		17	151	0	151	1
	• CV-2356/UYA-4(V), Sig Data Conv	61227956		6	137	0	137	0
	• OJ-195/UYA-4(V), Opns Sum Cons	78298141		3	133	0	133	2
	• AN/USQ-59, Data Terminal Set	58628650		4	101	0	101	0
	• AN/UYK-7(V), Computer Set		QK0S	17	224	0	224	0
	• Commnctn/Data Sys, ITAWDS		Q000 (QK03)	19	167	0	167	3
	SWAB 495-3 Total			352	4,456	8	4,464	24
511-1	Heating Systems							
	• Electrical Heater	0-0840012 (090840012)		1	204	0	204	0
	• Steam Heating Piping System		T10A	5	503	2	505	0
	• Convection Heater		T109	2	411	0	411	0
	SWAB 511-1 Total			8	1,118	2	1,120	0
512-1	Ventilation Systems							
	• Fan, Vaneaxial	400060910B		4	326	97	423	0
	• Starter Motor, Mag LVP SZ0	0-0840012 (151406637B)		1	204	0	204	0
	• Motor, AC, 2 Spd, 440 V	174031467B		4	128	72	200	0
	• Motor, AC, 2 Spd, 440 V	174031386P (174031386B)		3	62	120	182	0
	• Motor, AC, 2 Spd, 440 V	174031387B		2	16	120	136	2
	• Vlv Operator	619560057B		1	105	0	105	0
	• Vent Systems		T300	72	200	0	200	0
	SWAB 512-1 Total			87	1,041	409	1,450	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
514-2	Air Conditioning Plant							
	• Motor, AC, 440 V	174031473B		5	32	254	286	2
	• A/C Refrigeration Plant, 300 Ton	325013363B		26	166	22	188	0
	• A/C Refrigeration Plant, 300 Ton	325013363 (325010363B)		9	28	73	101	1
	• Pump, Ctfgl, 1,500 gpm	017030311B		6	85	20	105	1
	SWAB 514-2 Total			46	311	369	680	4
516-1	Ship's Service Refrigeration							
	• Compressor, Ctfgl	060050219B		5	252	0	252	1
521-1	Firemain & Flush System (Piping)							
	• Valve, Btfy, 12 IPS	882291673		76	2,810	9	2,819	1
	• Valve, Btfy, 10 IPS	882291570		52	992	0	992	0
	• Valve, Btfy, 8 IPS	88291568 (882291568)		26	720	0	720	0
	• Valve, Btfy, 6 IPS	882291560		11	123	0	123	0
	• Valve, Btfy, 4 IPS	882291558		4	435	0	435	0
	• Valve, Relief, 2.5 IPS	883116191B		13	192	154	346	0
	• Valve, Reducing, 2 IPS	882095737B		4	166	35	201	1
	• Valve, Operator	619560042B		7	111	0	111	0
	• Valve Actuator, Hydraulic	520630009B		3	110	0	110	0
	• Strainer, 2.5 in. w/Vlv	640010099		10	348	0	348	0
	• FM, Vlvs, Piping, Components		T801	43	919	50	969	0
	• Fire Extin Piping, Press Gages		T908	1	323	0	323	0
	• Flushing System		T803	9	164	2	166	0
	• Firemain System (Complete)		T800	17	151	6	157	0
	SWAB 521-1 Total			276	7,564	256	7,820	2
521-2	Firemain and Flushing System (Pumps)							
	• Pump, Ctfgl, 400 gpm (Bilge)	017030312 (017030312B)		5	468	0	468	1
	• Pump, Ctfgl, 2,000 gpm	016031943 (016032346B)		8	210	205	415	2
	• Motor, AC, 440 V	174031471B		4	131	0	131	0
	SWAB 521-2 Total			17	809	205	1,014	3

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
522-1	Sprinkler System							
	• Sol Valve, 440 V	882181926		8	158	0	158	0
	• Sol Valve, 115 V	882182020		9	134	0	134	0
	• FM Sprinkler System		T804	29	265	52	317	2
	SWAB 522-1 Total			46	557	52	609	2
523-1	Countermeasure Washdown System							
	• FM Washdown System		T805	7	169	0	169	1
524-1	Auxiliary Seawater Systems							
	• Motor, AC, 440 V	174031479B		4	166	207	373	2
	• Pump, Ctfgl, Aux Cond Circ	017030313B		5	137	0	137	1
	SWAB 524-1 Total			9	303	207	510	3
526-1	Deck Drains							
	• Deck Drains		TC06	27	472	367	839	0
	• Scuppers		TC04	5	152	149	301	0
	• Deck Drain Valves		TC07	3	104	0	104	1
	SWAB 526-1 Total			35	728	516	1,244	1
528-1	Plumbing Drains							
	• Piping and Valves		T706	12	366	0	366	1
	• Plumbing Installations		T700	12	70	32	102	0
	SWAB 528-1 Total			24	436	32	468	1

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
524-3	Ballast/Deballast System (Piping)							
	• 4-Valve Manifold	882 [illegible]		1	650	0	650	0
		[illegible]						
	• 4-Valve Manifold	[illegible]		5	175	0	175	1
	• 3-Valve Manifold	[illegible]		4	487	0	487	0
	• Ballast Hydraulic System	0481073019		7	614	32	646	1
		(Not Listed)	(TA05)					
	• Hydraulic Control Power Unit	[illegible]		6	254	0	254	0
	• Flow Switch, LS 1005	2134A0166		1	318	0	318	0
	• Hydraulic Pump, Axial Pstn	01[illegible]641B		3	190	0	190	2
	• Hydraulic Accumulator	926[illegible]040		1	101	0	101	0
	• Rty Actuator	5295[illegible]034B		5	164	0	164	0
	• Drain, Ballast, Trim System		TA00	4	376	6	382	0
	• Ballast-Trim, Drain		TA01	12	210	3	213	0
	• Ballast System Piping		TA03	5	127	0	127	3
	SWAB 524-3 Total			54	3,666	41	3,707	7
529-4	Ballast/Deballast System (Pumps)							
	• Air Compressor, LP, 2200 cfm	0[illegible]1		56	338	0	338	21
531-1	Flash Type Distilling Unit							
	• Pump, Ctfgl, Mn Distl	017033859B		4	181	0	181	0
	• Pump, Ctfgl, Brine Ovbd	017033864B		4	170	0	170	1
	• Pump, Ctfgl, SW Feed	017033863B		4	109	0	109	1
	• Motor, AC, 440 V	174031433B		2	115	0	115	0
	• Valve, Btfy, 8 IPS	8822[illegible]1568		6	177	0	177	0
	• Distillation Unit	08911[illegible]059B		14	149	0	149	2
	SWAB 531-1 Total			34	901	0	901	4
533-1	Potable Water Service							
	• Potable Water Service		TB03	16	217	0	217	0
534-1	Aux Stm, Stm Piping and Controls							
	• Aux Stm Supply Piping, Desuphtr		TH03	12	204	0	204	0
	• Valve Operators	619560050B		3	102	0	102	2
	• Valve Operators	619560055B		4	176	0	176	1
	SWAB 534-1 Total			19	482	0	482	3

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
534-7	LP Stm Drain System							
	• Steam Drains (Includes HP)		TH04	17	184	0	184	0
536-1	Auxiliary Fresh Water Cooling							
	• Cooling Systems		TB04	20	239	32	271	0
536-2	Electronic Equipment Cooling							
	• Pump, Ctfgl, 1[illegible] gpm	017030369B		2	153	0	153	0
541-1	Ship's Fuel, Fuel Compensation System							
	• Valve Operator	619560052B		4	231	137	368	1
	• Valve, Btfy, 6 IPS	8822917138 (882291713B)		4	101	0	101	0
	• FO System Piping and Accessories		F507	15	109	0	109	1
	SWAB 541-1 Total			23	441	137	578	2
542-1	Aviation and General Purpose Fuel Systems (Piping)							
	• JP-5 Service, Transfer, Blending		T605	31	797	142	939	2
	• JP-5 Hose Reel		T60A	1	220	0	220	0
	SWAB 542-1 Total			32	1,017	142	1,159	2
551-5	Air Compressors							
	• Motor AC, 440 V	174031477B		2	69	64	133	0
	• LPAC, 2[illegible] cfm	061900356B		49	700	0	700	7
	• LPAC, 5[illegible] cfm	061900270		40	584	0	584	2
	SWAB 551-5 Total			91	1,353	64	1,417	9
553-3	O_2N_2 Plant							
	• Compressor	061330002B		10	121	0	121	0
	• O_2N_2 System		TG03	2	109	0	109	2
	SWAB 553-3 Total			12	230	0	230	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
555-1	Fog Foam and AFFF							
	• AFFF Proportioner	649000003		30	2,307	46	2,353	8
	• AFFF Proportioner	649000 (649000003)		2	264	0	264	0
	• AFFF Proportioner	629000003 (649000003)		1	260	0	260	0
	• AFFF Proportioner	64900003 (649000003)		2	218	0	218	1
	• Motor, AC, 440 V	174 31499B		8	233	0	233	0
	• Foam Generating Equipment		T903	13	487	183	670	3
	SWAB 555-1 Total			56	3,769	229	3,998	12
555-2,3	Dry Chemical and CO_2 Extinguishing							
	• CO_2 1 Dry Chemical		T901	8	203	52	255	0
	• CO_2 Cylinders and Fixed CO_2 Systems	2-930054054 (930054054)		7	103	0	103	0
	SWAB 555-2,3 Total			15	306	52	358	0
561-1	Steering System							
	• Steering Gear	600230038B		12	730	0	730	1
	• Valve, Hydraulic Sol	882234039B		4	122	0	122	0
	• Steering Gear, Hydraulic	930250021 (600230038B)		3	0	120	120	0
	• Electric, Hydraulic RAM	600230038 (600230038B)		2	110	0	110	6
	SWAB 561-1 Total			21	962	120	1,082	7
57X-X	RAS and Cargo Handling							
	• Cargo Elevator, Monorails, Conveyor		TN03	18	243	0	243	4
	• Cranes, Hoists, Paravanes		TN01	10	162	3	165	0
	SWAB 57X-X Total			28	405	3	408	4

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
571-1	RAS Winches							
	• Saddle Winch Distribution Panel	611320060B		3	165	0	165	2
	• Circuit Card Assy	611320073B		2	133	0	133	0
	• Circuit Card Assy	611320077B		2	232	0	232	0
	SWAB 571-1 Total			7	530	0	530	2
571-3	RAS Transfer Head and Sliding Blocks							
	• Probe Carrier Assy	990200006		14	132	1	133	0
	• Hydraulic Accumulator	926050002		1	120	0	120	0
	SWAB 571-3 Total			15	252	1	253	0
572-1	Ship's Stores Handling Equipment							
	• Vertical Conveyor Tray	590390110B		8	135	0	135	3
573-1	Cargo Handling Elevators							
	• Elevator, 12,000 Lb Cap (Fwd)	590330072B		35	490	0	490	0
	• Elevator, 12,000 Lb Cap (Aft)	590330092B		7	408	0	408	0
	• Elevator, Cargo	09160423010 (Not Listed)	(TN03)	27	259	1	260	0
	SWAB 573-1 Total			69	1,157	1	1,158	0
573-2	Cargo Conveyors							
	• Starter Motor, MAGLVP	151209544B		1	150	0	150	0
	• Longitudinal Conveyor	09160439010 (Not Listed)	(TN04)	8	128	0	128	0
	• Cargo Conveyor		TN00	1	145	0	145	0
	SWAB 573-2 Total			10	423	0	423	0
573-3	Below Deck Cargo Handling							
	• Pallet Transporter	[illegible]4253B		91	591	0	591	0
	• Pallet Transporter, Hyd Sys	[illegible]4253B		37	479	0	479	0
	• Pallet Transporter, Steering Sys	[illegible]4253B		19	161	0	161	2
	SWAB 573-3 Total			147	1,231	0	1,231	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	AFL Number (Validated)	FIC Number (Validated)	Historical Maintenance Summary				
				CMA	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
573-4	Fork Lift Trucks							
	• FL Truck, 6,000	[illegible]		101	959	0	959	0
	• FL Truck, 10,000	950004254B		9	313	135	448	1
	• FL Truck, 4,000	950004131B		30	247	0	247	1
	• FL Truck, Electrical Equip	950004131B		26	186	0	186	0
	• Fl Truck, 4,000 EMD	950004130B		32	174	0	174	0
	• FL Truck, 10,000, Steering Grp	950194254B		15	153	3	156	1
	• Body Grp	950224253B		12	109	0	109	0
	SWAB 573-4 Total			225	2,141	138	2,279	3
573-6	Cargo Booms, Rigging, Misc Hardware							
	• Cargo Handling - Ship, Dockside		TS00	6	174	0	174	0
582-1	Mooring and Towing							
	• Capstan, Electric, 2 Spd	531020003 (531020003B)		2	91	72	163	1
	• Towing Winch	620070033B		3	150	0	150	0
	• Lashing, Mooring, Towing Fittings		1101	20	189	20	209	0
	SWAB 582-1 Total			25	430	92	522	1
583-1	Boat Handling, Stowage							
	• Boat Handling Equip, Misc	282[illegible]14001 (282[illegible]14001)		36	68	298	366	0
	• Boat Winch	62[illegible]42265B		4	147	8	155	5
	• Boat Crane		Y000	11	17	200	217	0
	• Boat Davit		Y004	7	341	20	361	0
	SWAB 583-1 Total			58	573	526	1,099	5
583-3	Small Boats							
	• Boat, Craft Equipage	282[illegible]40001		17	112	36	148	0
583-4	Landing Craft							
	• Diesel Engine, 300 HP (LCP)	666[illegible]0237		28	442	9	451	1
	• Diesel Engine, 225 HP (LCM-6)	666[illegible]0087		15	256	0	256	1
	SWAB 583-4 Total			43	698	9	707	2

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	AEL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
584-2	Mechanically Operated Gates							
	• Stern Gate Operating Mech	31 12[illegible]001B		13	350	0	350	9
	• Stern Gate Operating Mech	31[illegible]001B (31012[illegible]001B)		3	266	0	266	1
	• Stern Gate		AD04 (AD03)	12	312	0	312	1
	SWAB 584-2 Total			34	928	0	928	11
584-3	Mechanically Operated Ramps							
	• Pump, Axial Piston Hyd	01916[illegible]638B		1	152	0	152	0
	• Vehicle Ramp Access	85[illegible]772B		11	150	0	150	0
	SWAB 584-3 Total			12	302	0	302	0
588-1	Aircraft Elevators							
	• A/C Elevator, [illegible] LB	[illegible]033[illegible]95B		20	556	0	556	7
	• A/C Elevator, 8, [illegible] LB	[illegible]30655 ([illegible]033[illegible]95B)		9	393	0	393	8
	• A/C Elevator, 40, [illegible] LB	5[illegible]033[illegible]96 (5[illegible]033[illegible]96B)		4	233	0	233	2
	SWAB 588-1 Total			33	1,182	0	1,182	17
588-2	A/C, Helo Handling, Support Equi;							
	• Helo Crash Crane	[illegible]2736		17	231	40	271	1
	• A/C Crane, [illegible],000	[illegible]2B		20	242	0	242	7
	SWAB 588-2 Total			37	473	40	513	8
584-2	Bridge and Other Moving Cranes							
	• Monorail System	85[illegible]767B		17	407	0	407	0
	• Monorail System	85[illegible]767 ([illegible]767B)		6	391	0	391	0
	• Monorail Chain Hoist	58[illegible]83 (58[illegible]83B)		11	1,313	0	1,313	0
	• Monorail Chain Hoist	58[illegible]083B		18	361	0	361	0
	• Monorail Trolley Assy	85[illegible]720B		1	220	0	220	4
	• Monorail Diesel Engine	66715[illegible]02B		5	130	0	130	0
	• Crane, Bridge, Travel	57[illegible]004B		4	128	0	128	0
	SWAB 584-2 Total			62	2,950	0	2,950	4

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
589-3	Escalators/Personnel Elevators							
	• Personnel Elevator, 1,6[illegible] Lb	5906[illegible]02B		8	151	0	151	0
	• Personnel Elevator, 1,6[illegible] Lb	5906[illegible]02A (5906[illegible]02B)		2	127	0	127	2
	SWAB 589-3 Total			10	278	0	278	2
593-3	Solid Waste							
	• Incinerator	3021[illegible]002		1	1	101	102	1
611-1	Hull Fittings							
	• Hull Fittings		1100	11	44	134	178	0
612-2	Rails, Stanchions, Lifelines							
	• Safety Nets, Guards, Rail		1103	65	446	160	606	0
622-1	Floors, Plates, Gratings							
	• Gratings and Covers		1404	7	119	7	126	0
623-1	Ladders, Accommodations							
	• Ladder Shields		1405	1	1	116	117	0
623-2	Accommodation Ladders							
	• Movable Ladders		1403	29	238	194	432	0
624-1	Non-Structural Closures							
	• Doors		1503	35	300	96	396	0
634-1	Deck Covering							
	• Covering		1600	8	146	0	146	1
637-1	Sheathing and Covering							
	• Wood Belting		A103	6	186	0	186	0
640-1	Berthing, Leisure, Community Spaces							
	• Combination Locks, Staterooms		T800 (1100)	11	151	6	157	0

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	APL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
651-1	Commissary Spaces							
	• Dishwashing Mach, Cmrl	430000695B		13	309	0	309	1
	• Dishwashing Mach, CPO	430240047		19	207	16	223	1
	• Dishwashing Mach	431070011B		13	140	0	140	0
	• Stm Jacket Cooker	432410007		19	106	0	106	1
	• Galley Equip		1B01	47	160	40	200	2
	• Grease Vent Hood		T301	6	163	0	163	0
	• SWAB 651-1 Total			117	1,085	56	1,141	5
654-1	Utility Spaces							
	• Sweeper		1910 (1912)	25	132	0	132	0
655-1	Laundry and Dry Cleaning Spaces							
	• Washer Extractor	910570040		11	156	0	156	1
	• Washer/Extractor	910570050		9	119	0	119	0
	• Dry Cleaning Press	910250021		7	117	0	117	0
	• Dryer Tumbler	910240013		9	141	0	141	0
	SWAB 655-1 Total			36	533	0	533	0
660-1	Working Spaces							
	• Submer Pump, 2.5 in.	2-470004035 (C470004005)		10	88	14	102	0
	• DC Pump, 250 gpm	010430001		8	222	26	248	0
	• Portable Submersible Pump	917710005		6	38	160	198	0
	• DC Lockers, Equipment		1805	3	55	88	143	1
	• Repair Locker		1B03 (1803)	21	103	0	103	2
	• WS Lab, Test Area		1900	17	403	66	469	1
	SWAB 660-1 Total			65	909	354	1,263	4

(continued)

Table B-1. (continued)

SWAB Number	Nomenclature	AEL Number (Validated)	EIC Number (Validated)	Historical Maintenance Summary				
				CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
66A-1	HM&E Workshops							
	• Stowage Lockers		1800	57	380	88	468	1
	• Portable Electric Tools		197L (191L)	1	200	0	200	0
	• Welding Machine	820 23011		2	73	130	203	0
	• Motor, A.C., 440 V	1740.31434B		2	140	0	140	0
	SWAB 66A-1 Total			62	793	218	1,011	1
711-1	Rails and Mounts							
	• Pri Fir Sighting	444 2226		7	95	40	135	3
721-1	Missile Launching System							
	• Carriage, MK 11 Mod	1622[illegible]03		14	64	53	117	0
	• Control Panel, MK 67 Mod 3	1622[illegible] (1622[illegible])		1	400	0	400	1
	SWAB 721-1 Total			15	464	53	517	1
			Total	6,041	119,872	10,913	130,785	460

APPENDIX C

LHA-1 CLASS RANKED LISTING OF MAINTENANCE-CRITICAL SYSTEMS

Table C-1 is a list of LHA-1 Class maintenance-critical systems by SWAB, ranked in decending order according to the total number of critical corrective maintenance (CMA_C) man-hours reported. This list was developed from the list of maintenance-critical systems and equipments presented in Table B-1. Descriptions of data elements in Table C-1 are as follows:

- Rank: The relative ranked position of one system to another based on the total number of CMA_C man-hours reported.
- SWAB number: The ship work authorization boundary number for the identified system as defined in NAVSEA 0900-LP-098-6010.
- Nomenclature: The name of the identified system or equipment.
- Annualized maintenance summary: A summary of historical maintenance burden indicators for each identified system. Maintenance burden indexes are stated as an average value per ship operating year. The MDS data base from which values were derived contained 3.4 years of operational maintenance history for the LHA-1 and 2.0 years for the LHA-2; therefore, the displayed value is the total value divided by 5.4 years.
- CMA_C: The average number of critical corrective maintenance actions per year reported for each identified system.
- Ship's force man-hours: The average number of ship's force man-hours reported per year for accomplishment of CMA_C on the identified system during the reporting period.
- IMA man-hours: The average number of intermediate maintenance activity CMA_C man-hours reported.
- Total man-hours: The average total number of CMA_C man-hours (ship's force plus IMA) reported.
- Number of CASREPs: The average number of casualty reports compiled via the consolidated casualty reporting system for the identified maintenance-critical system.

Table C-1. LHA-1 CLASS RANKED LISTING OF MAINTENANCE-CRITICAL SYSTEMS

Rank	SWAB Number	Nomenclature	Annualized Maintenance Summary (Rounded to Nearest Whole Number)				
			CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
1	453-1	Height Finding Radar	22	2,678	0	2,678	1
2	521-1	Firemain and Flushing System (Piping)	51	1,401	47	1,448	0*
3	252-1	Automatic Propulsion Control (Incl Main, Auxiliary, SSTG)	72	1,318	59	1,377	2
4	432-1	Telephone Systems	56	1,296	8	1,304	0
5	498-3	Tactical Support Center, SP CL Purpose Intel Sys	65	825	2	827	4
6	423-1	Electronic Navigation	12	779	0	779	3
7	555-1	Fog Foam and AFFF	10	698	42	740	2
8	529-3	Ballast/Deballast System (Piping)	10	679	8	687	1
9	436-1	Alarm, Safety, and Warning Systems	9	680	0*	680	0*
10	589-2	Bridge and Other Moving Cranes	11	546	0	546	0*
11	221-1	Propulsion Boilers	23	269	177	446	6
12	434-1	Entertainment and Training TV	21	438	0*	438	0
13	573-4	Fork Lift Trucks	42	396	26	422	0*
14	440-4	Message Processing Distribution System	15	422	0	422	2
15	437-1	Indicating, Order, and Metering Systems	24	375	2	377	0*
16	312-1	Emergency Diesel Generator Set	13	302	68	370	2
17	481-1	Gunfire Control Systems	29	352	2	354	4
18	441-5	Communications Transceivers	64	310	3	313	8
19	167-1	Watertight Doors, Hatches, and Scuttles	25	259	35	294	0*
20	431-1	IC Switchboards	38	290	3	293	0*
21	512-1	Ventilation Systems	16	193	76	269	0*
22	551-5	Air Compressors	17	251	12	263	2
23	491-1	Electronics, Test, Checkout, and Monitoring Equip	18	186	67	253	0*
24	660-1	Working Spaces	12	168	66	234	0*
25	526-1	Deck Drains	6	135	96	231	0*

*Actual number computed less than 1.0

(continued)

Table C-1. (continued)

Rank	SWAB Number	Nomenclature	Annualized Maintenance Summary (Rounded to Nearest Whole Number)				
			MA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
26	573-3	Below Deck Cargo Handling	18	227	0	227	0*
27	588-1	Aircraft Elevators	6	219	0	219	3
28	542-1	Aviation and General Purpose Fuel Systems (Piping)	6	188	26	214	0*
29	573-1	Cargo Handling Elevators	13	214	0*	214	0
30	651-1	Commissary Spaces	22	201	10	211	0*
31	511-1	Heating Systems	1	207	0*	207	0
32	583-1	Boat Handling and Stowage	11	106	97	203	0*
33	330-1	Lighting Distribution and Fixtures	16	183	19	202	0
34	561-1	Steering System	4	178	22	200	1
35	521-2	Firemain and Flushing System (Pumps)	3	150	38	188	0*
36	665-1	HM&E Workshops	11	147	40	187	0*
37	261-2	Fuel Oil Service Pumps	3	178	1	179	4
38	584-2	Mechanically Operated Gates	6	172	0	172	2
39	531-1	Flash Type Distilling Unit	6	167	0	167	0
40	320-1	Power Cable	2	161	0	161	0
41	421-1	Non-Electric/Electronic Navigation Systems	9	34	11	145	0
42	446-1	Security Equipment	15	141	0	141	0
43	254-2	Auxiliary Condenser and Air Ejector	2	122	15	137	2
44	255-3	Main Feed, Booster, Emergency, and Transfer Pumps	4	61	70	131	0*
45	583-4	Landing Craft	8	129	2	131	0*
46	514-2	Air Conditioning Plant	9	58	68	126	0*
47	433-1	Announcing Systems	5	121	0	121	0
48	221-3	Boiler Blow System	1	15	102	117	0
49	255-2	Main Feed Pump	5	115	0	115	0*
50	522-1	Sprinkler System	12	103	10	113	0*

*Actual number computed less than 1.0.

(continued)

Table C-1. (continued)

Rank	SWAB Number	Nomenclature	Annualized Maintenance Summary (Rounded to Nearest Whole Number)				
			CMA $_c$	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
51	612-2	Rails, Stanchions, and Lifelines	12	83	30	113	0
52	441-2	Antenna Multicouplers and Tuners	9	108	0	108	1
53	541-1	Ship's Fuel and Fuel Compensation System	4	82	25	107	0*
54	655-1	Laundry and Dry Cleaning Spaces	7	99	0	99	0*
55	571-1	RAS Winches	1	98	0	98	0*
56	582-1	Mooring and Towing	5	80	17	97	0*
57	588-2	Aircraft and Helicopter Handling and Support Equipment	7	88	7	95	2
58	721-1	Missile Launching System	3	86	10	96	0*
59	493-1	Management Data Processing System	14	95	0	95	0
60	524-1	Auxiliary Sea Water Systems	2	56	38	94	0*
61	314-2	400 Hz Motor Generator	3	70	24	94	0*
62	441-1	Communications Antenna Systems	5	90	2	92	2
63	426-1	Gyro Compass System	2	51	40	91	0*
64	534-1	Auxiliary Steam, Steam Piping, and Controls	6	89	0	89	0*
65	528-1	Plumbing Drains	4	81	6	87	0*
66	311-1	Ship's Service Steam Turbine Generator Set	2	41	45	86	2
67	253-1	Main Steam Piping	0*	31	55	86	0*
68	255-5	Main Condensate Pump	0*	11	74	85	0*
69	441-6	Remote Communications Devices	8	82	3	85	1
70	623-2	Accommodation Ladders	5	44	36	80	0
71	573-2	Cargo Conveyors	2	78	0	78	0
72	57X-X	RAS and Cargo Handling	5	75	0*	75	0*
73	471-1	Active ECM	1	75	0	75	0*
74	437-2	Tank Level Indicating System	2	74	0	74	0
75	624-1	Non-Structural Closures	6	56	17	73	0

*Actual number computed less than 1.0.

(continued)

Table C-1. (continued)

Rank	SWAB Number	Nomenclature	Annualized Maintenance Summary (Rounded to Nearest Whole Number)				
			CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
76	452-1	Air Search Radar	5	73	0	73	2
77	472-1	Passive ECM	5	67	0*	67	0*
78	555-2/3	Dry Chemical and CO_2 Extinguishing	3	57	10	67	0
79	529-4	Ballast and Deballast System (Pumps)	10	63	0	63	4
80	254-1	Main Condenser and Air Ejector	1	33	27	60	0*
81	150-1	Superstructure	1	60	0	60	0
82	451-1	Surface Search Radar	5	58	0	58	0*
83	584-3	Mechanically Operated Ramps	2	56	0	56	0
84	441-4	Communications Receivers	5	56	0	56	0
85	589-3	Escalators and Personnel Elevators	2	51	0	51	0*
86	536-1	Auxiliary Fresh Water Cooling	4	44	6	50	0
87	120-1	Structural Bulkheads and Decks	5	50	0	50	0*
88	441-3	Communications Transmitters	6	49	0	49	0*
89	264-3	Lube Oil Purifiers	2	33	16	49	0*
90	571-3	RAS Transfer Head and Sliding Blocks	3	47	0*	47	0
91	516-1	Ship's Service Refrigeration	1	47	0	47	0*
92	320-2	Electrical Power Switchgear and Panels	0*	45	0	45	0
93	553-3	O_2N_2 Plant	2	43	0	43	0*
94	533-1	Potable Water Service	3	40	0	40	0
95	482-1	Missile Fire Control Systems	16	36	0	36	1
96	637-1	Sheathing and Covering	1	34	0	34	0
97	534-7	LP Steam Drain System	3	34	0	34	0
98	611-1	Hull Fittings	2	8	25	33	0
99	573-6	Cargo Booms, Rigging, and Miscellaneous Hardware	1	32	0	32	0
100	523-1	Countermeasure Washdown System	1	31	0	31	0*

*Actual number computed less than 1.0.

(continued)

Table C-1. (continued)

Rank	SWAB Number	Nomenclature	Annualized Maintenance Summary (Rounded to Nearest Whole Number)				
			CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
101	640-1	Berthing, Leisure, and Community Spaces	2	28	1	29	0
102	243-1	Propulsion Shafting	2	14	15	29	1
103	536-2	Electronic Equipment Cooling	0*	28	0	28	0
104	244-1	Propulsion Shaft Bearings	0*	28	0	28	0
105	583-3	Small Boats	3	21	7	28	0
106	634-1	Deck Covering	1	27	0	27	0*
107	251-1	Forced Draft Blowers	3	26	0	26	0
108	711-1	Guns and Mounts	1	18	7	25	0*
109	572-1	Ship's Stores Handling Equipment	1	25	0	25	0*
110	654-1	Utility Spaces	5	24	0	24	0
111	43X-X	IC Systems	3	20	4	24	0*
112	622-1	Floors, Plates, and Gratings	1	22	1	23	0
113	231-1	Propulsion Steam Turbines	0*	23	0	23	0*
114	492-3	Pilot Landing Aid, TV System	1	23	0	23	0
115	445-1	Teletype and Facsimile	2	22	0	22	0*
116	623-1	Ladders, Accommodations	0*	0*	22	22	0
117	342-1	Diesel Generator Support Systems	0*	21	0	21	0
118	455-1	Identification System (IFF)	4	19	0	19	0*
119	593-3	Solid Waste	0*	0*	19	19	0*
		Totals	1,107	22,097	2,002	24,099	85

*Actual number computed less than 1.0.

APPENDIX D

LHA-1 CLASS CASREP-SIGNIFICANT SYSTEMS AND EQUIPMENTS

Table D-1 is a list of systems and equipments identified from casualty reports compiled via the consolidated casualty reporting system by the LHA-1 and LHA-2 during the reporting period from LHA-1 commissioning through December 1979. These CASREP-significant systems and equipments were categorized as those which had accumulated an average of one or more CASREPs per ship per year, but which had not accumulated 100 or more critical corrective maintenance (CMA_C) man-hours. (Those systems and equipments which had accumulated 100 or more CMA_C man-hours are identified in Appendixes B and C.) Descriptions of data elements in Table D-1 are as follows:

- SWAB number: The ship work authorization boundary number for the identified system as defined in NAVSEA 0900-LP-098-6010.
- Nomenclature: The name of the identified system or equipment.
- APL number (validated): The allowance parts list number for the identified equipment. APL numbers were reported via the MDS by forces afloat and validated through comparison with the Type Commander's COSAL. If the APL number was found to be incorrect, the corrected APL number is tabulated in parentheses immediately following the reported APL number.
- Historical maintenance summary: A profile of historical critical maintenance burden indicators for each identified system and equip-equipment.
- CMA_C: The number of critical corrective maintenance actions reported for each identified system and equipment.
- Ship's force man-hours: The total number of ship's force man-hours reported for accomplishment of CMA_C on the identified system or equipment during the reporting period.
- IMA man-hours: The total number of intermediate maintenance activity CMA_C man-hours reported.
- Total man-hours: The total number of CMA_C man-hours (ship's force plus IMA) reported.
- Number of CASREPs: The total number of casualty reports compiled via the consolidated casualty reporting system for the identified CASREP-significant system or equipment.

Table D-1. LHA-1 CLASS LISTING OF CASREP-SIGNIFICANT SYSTEMS AND EQUIPMENTS NOT CATEGORIZED AS MAINTENANCE-CRITICAL

SWAB Number	Nomenclature	APL Number (Validated)	Critical Maintenance Summary				Number of CASREPs
			CMA_c	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	
255-2	Main Condensate Pump • Vac Pump, Rty Pwr, 4.2 cfm	6167200688	2	5	0	5	2
261-2	Fuel Oil Service Pumps • Pump, Rty Pwr, [illegible] gpm	6161605?8	4	68	0	68	4
437-1	Indicating, Order, and Metering Systems • Actuator, Electromechanical Rty	619980262B	3	56	0	56	2
440-4	Message Processing Distribution System • TT-576A/UG • AN/UGC-44, Teletypewriter Set	42901631 58139093	7 9	23 89	0 0	23 89	5 6
	SWAB 440-4 Total		16	112	0	112	11
441-1	Communications Antenna Systems • [illegible] • [illegible] • [illegible]	78185610 62664920 62692262	1 13 6	18 69 37	0 6 0	18 75 37	10 2 3
	SWAB 441-1 Total		20	124	6	130	15
441-3	Communications Transmitters • AM-[illegible] • AN/[illegible] • [illegible]	52463219 58567A60CL 62721710	16 14 1	60 88 2	0 0 0	60 88 2	26 2 6
	SWAB 441-3 Total		31	150	0	150	34

(continued)

Table D-1. (continued)

▸SWAB Number	Nomenclature	APL Number (Validated)	Critical Maintenance Summary				
			CMA_C	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Number of CASREPs
441-4	Communications Receivers						
	• AN/URR-67, Receiver Set	58533370CL	6	30	0	30	4
441-6	Remote Communications Devices						
	• AM 6148 ARC-138(V), Amp	52504851 (52504866)	5	11	0	11	11
	• AM 6148 ARC-138(V), LBA, Amp	52504866	0	0	0	0	9
	• PP-6747/UR, Power Supply	79607118	1	2	0	2	8
	SWAB 441-6 Total		6	13	0	13	28
461-1	Gunfire Control Systems						
	• Converter, Signal Data, Mk 69 Mod 1	49402752	4	16	0	16	2
542-1	Aviation and General Purpose Fuel Systems (Piping)						
	• Valve FLT 2.5" IPS	882220454B	0	0	0	0	4
543-1	Boat Handling and Stowage						
	• Circuit Card Assembly	611320963B	0	0	0	0	3
584-2	Bridge and Other Moving Cranes						
	• Hoist Cargo Monorail, Cap, 6,000 LB	5807600898	1	40	0	40	7
711-1	Guns and Mounts						
	• Slide, Mk 32 Mod 0	006040006	1	0	1	1	2
	• Shield, Mk 63 Mod 0	006040009	5	60	0	60	2
			6	60	1	61	4
721-1	Missile Launching System						
	• Test Set, Mk 504 Mod 0	006220008	8	11	0	11	2

APPENDIX E

LHA-1 CLASS MAINTENANCE-CRITICAL/CASREP-SIGNIFICANT EQUIPMENTS HAVING COMMONALITY WITH EQUIPMENTS OF OTHER EOC SHIP CLASSES

Table E-1 is a list of LHA-1 Class equipments, identified in Appendix A as maintenance-critical or in Appendix D as CASREP-significant, that have commonality with equipments of other EOC ship classes. Commonality was established through a comparison of allowance parts list (APL) numbers contained in the Type Commander's COSALs for Atlantic and Pacific Fleet ships. The following ship classes were used in the comparison:

DDEOC/ LO-MIX	PEOC
DD-963	LPH-2
DDG-37	LPD-4
FF-1052	LSD-36
CG-16	
CG-26	LST-1179
FFG-7	LKA-113

Destroyer engineered operating cycle (DDEOC) and LO-MIX engineered operating cycle ship classes were used for comparison to identify equipments previously subjected to an in-depth maintenance analysis. Amphibious engineered operating cycle (PEOC) ship classes were used for comparison to identify equipments that could, if subjected to an in-depth maintenance analysis, aid in identifying EOC requirements for ship classes other than the LHA-1 Class. This comparison also identifies an additional base of historical maintenance data for use in future analyses. Descriptions of data elements in Table E-1 are as follows:

- SWAB number: The ship work authorization boundary number for the identified equipment, as defined in NAVSEA 0900-LP-098-6010.
- Nomenclature: The name of the identified equipment.
- APL number: The allowance parts list number for the identified equipment.
- DDEOC/LO-MIX commonality: An indication that the equipment is or is not installed on one or more ships of one or more DDEOC/ LO-MIX ship classes. Equipments previously subjected to a DDEOC/ LO-MIX maintenance analysis are indicated by a dagger (†).

- PEOC commonality: An indication that the equipment is or is not installed on one or more PEOC ship classes other than the LHA-1.

Table E-1. LHA-1 CLASS MAINTENANCE-CRITICAL/CASREP-SIGNIFICANT EQUIPMENTS HAVING COMMONALITY WITH EQUIPMENTS OF OTHER EOC SHIP CLASSES

SWAB Number	Nomenclature	APL Number	DDEOC/LO-MIX Commonality*	PEOC Commonality**
221-1	Globe Valve, 0.75 psi	882056639	x	
261-2	Hand Stripping Pump	016200238	x	x
261-2	Pump, 550 gpm	016160528	x	
264-3	Lube Oil Purifier Motor	174752251		x
264-3	Centrifugal Lube Oil Purifier	760200200		x
320-2	AC Relay, 115 V, 1 Pole 0.84 Amp	199990009	x	x
330-1	Electric Hand Lantern, 115 V	249990138	x	x
330-1	Light Distribution Fuse Box, Type 18-S†	999970243	x	x
330-1	Flrsnt Lighting Fixture, Type MS-191*	249990746	x	x
342-1	Fuel Oil Pump, 11 gpm, 21 psi	016160559	x	
421-1	Navigation Equipment, Viewing	C240034024	x	x
421-1	Handheld Binocular	C240034032	x	x
421-1	Clock, General Purpose	C240054131	x	x
423-1	AN/URD-4D, Direction Finder Set*	58462620	x	x
423-1	AN/UQN-4, Sonar Sounding Set†	58413400	x	x
426-1	Gyro Compass, Mk 19 Mod 3-D*	252360646	x	
432-1	Head Set, H-200 U	671	x	x
432-1	LS-444 WIH, Loudspeaker*	72754400	x	x
432-1	Telephone Terminal Box	999970045	x	x
432-1	Telephone Terminal Box	999970015	x	x
433-1	AM-2316 C/SIA, Amplifier	5223161		x
433-1	AN/SIA-118A, Amplifier-Oscillator	569052		x
433-1	AM-4154/SIA, Announcing System	5223161SFA		x
437-1	Amplifier, Synchro Signal	2	x	x

*Equipment is installed on one or more ships of the following DDEOC/LO-MIX ship classes: DD-963, DDG-37, FF-1052, CG-16, CG-26, or FFG-7.

**Equipment is installed on one or more ships of the following prospective amphibious EOC ship classes: LPH-2, LPD-4, LSD-36, LST-1179, or LKA-113.

†Equipment has previously been subjected to a maintenance analysis during the DDEOC/LO-MIX EOC Program development.

(Continued)

Table E-1. (continued)

SWAB Number	Nomenclature	APL Number	DDEOC/LO-MIX Commonality*	PEOC Commonality**
437-1	Indicator Transmitter, Mk 6 Mod 0	870010151	x	x
440-4	AN/UGC-49, Teletypewriter Set	58139093	x	
441-1	AS-2813/SRC Radio Antenna	59309951		x
441-1	CU-1781/SRA-34(V), Antenna Coupler	62692262	x	
441-2	AN/URA-38A, Antenna Coupler Group+	58433801	x	x
441-2	AN/SRA-60V, Coupler Group	57102360CL		x
441-3	AN/WRT-1A, CBXP Radio	59010104	x	x
441-4	R-390A/URR, Radio Receiver+	81039001	x	x
441-5	AN/VRC-46, Radio Set+	58841200	x	x
441-6	SB-1505C/SP, Signal Distribution Swbd+	85215003	x	
441-6	AN/URA-17C, Comparator-Converter	58431601	x	x
446-1	TSEC/KW-7 Teletype	92601500	x	
451-1	AN/SPS-10F, Radar Set+	57036630	x	x
452-1	AN/SPS-40B, Radar Set+	57039655	x	
455-1	AN/UPX-23, Interrogator Set+	58393723	x	x
471-1	AM-4530A/ULQ-6A, Radio Freq Amp	52503132	x	x
472-1	AN/WLR-1C, Receiver with Tuner+	58981717	x	x
472-1	AN/WLR-1C, PCI+	58981730	x	x
481-1	AN/SPQ-9, Radar Set+	49402746	x	
481-1	AN/SPG-60, Radar Set+	49402749	x	
481-1	Radar Antenna, Mk 39 Mod 0	49402748	x	
481-1	Gun Control Console, Mk 68 Mod 4+	49402225	x	
481-1	Converter, Signal Data, Mk 69 Mod 1	49402752	x	
482-1	Missile Fire Control System, Mk 115 Mod 0+	49401309	x	x
491-1	AN/USM-281C, Oscilloscope	58617020	x	x
495-3	AN/UYK-7(V), Computer Set+	58735398CL	x	
495-3	PPI Display Console, OA-7979(V)-10/UYA-4(V)+	78C49077	x	
495-3	RO-280/UYK, Line Printer	83315451	x	

(continued)

Table E-1. (continued)

SWAB Number	Nomenclature	APL Number	DDEOC/LO-MIX Commonality*	PEOC Commonality**
495-3	CV-2036(V)/USQ-20(V), Digital Converter†	62762811	x	
495-3	C-8408(P)-AN/UYK-7(V), Controller†	61399848	x	
495-3	CV-2356/UYA-4(V), Sig Data Converter	61227956	x	
521-1	Valve, Btfy, 10 IPS	882291570	x	
521-1	Valve, Btfy, 8 IPS†	882291568	x	
521-1	Valve, Btfy, 6 IPS†	882291560	x	x
521-1	Valve, Btfy, 4 IPS†	882291558	x	
521-1	Valve, Reducing, 2 IPS	882095737B	x	
521-1	Valve, Actuator, Hydraulic	520630009B	x	
521-1	Strainer, 2.5 Inch with Valve	64001009	x	x
522-1	Solenoid Valve, 0.37 IPS†	882181926	x	x
529-3	Flow Switch, LS 1900	213480166		x
529-4	Air Compressor, LP, 2,200 cfm	061250001		x
531-1	Valve, Btfy, 8 IPS†	882291568	x	
551-5	Air Compressor, LP, 50 cfm	061900270		x
555-1	AFFF Proportioner	649000003	x	
555-2/3	CO_2 Cylinders and Fixed CO_2 Systems	C930054054	x	x
571-3	Probe and Carrier Assembly	990200006		x
573-4	Fork Lift Truck, 6,000	950003459		x
583-3	Boat and Craft Equipage	C820004001	x	x
583-4	Diesel Engine, 300 HP	666010237		x
583-4	Diesel Engine, 225 HP	666010087		x
588-2	Helicopter Crash Crane	950002736		x
593-3	Incinerator	302100002		x
655-1	Dry Cleaning Press	910250021	x	x
655-1	Dryer Tumbler	910240013	x	
660-1	Submersible Pump, 2.5 in.	C470004005		x
660-1	DC Pump, 250 gpm†	019430001	x	x
660-1	Portable Submersible Pump†	017710005	x	x
665-1	Welding Machine	820020011	x	x
711-1	Slide, Mk 32 Mod 0†	006040006	x	
711-1	Shield, Mk 63 Mod 0†	006040009	x	
721-1	Test Set, Mk 509 Mod 0	006220008	x	
721-1	Carriage, Mk 11 Mod 0	006220003	x	x
721-1	Control Panel, Mk 65 Mod 3	006220006	x	x

END